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There has never been a time in the history of the electrical industry in the United States when there were so many indications of prosperity and so much hope for the future as at present. News comes almost daily of large additions to the plant of some manufacturing company, made in order to meet the demands for its products both at home and abroad. Many companies state that they now have orders sufficient to keep them busy for months to come. The development of a large foreign market, which is going on steadily, should make the industry more stable, and tend to create a steady demand. In short, everything points to continued prosperity for many years to come.

THE MAKING OF WORKMEN.

Industrial supremacy, in so far as the term may apply to this country at least, comes from men rather than from conditions. What success has been gained by American manufacturers and engineers has been due more to the habit of mind, the quickness of apprehension and freedom from tradition of the American mechanic than to any other single group of causes. Of course we have a country abounding in natural wealth, and conditions in it that make for opportunity; but the mental alertness of the people, their mechanical training, their instinct for invention, their adaptability, have been the factors that have brought us from a purely agricultural commonwealth to the first rank of the nations producing manufactured articles and in the conquest of natural difficulties.

When one contrasts the method of training men for the mechanical arts to-day with those that obtained a generation ago, the difference is so great and so striking as to lead inevitably to the natural inquiry if the next generation will perpetuate the traditions that have marked the past and produce such examples of inventors, mechanics, engineers and men of science as have ornamented the recent history of these states. Perhaps, under the present circumstances, one may take a pessimistic view and say that the race of skilled artisans is becoming extinct in the United States. But this view would be a narrow one, and is at least open to contradiction.

We have probably the most elaborate system of technical schools in the world. We have schools of engineering of high rank, capably administered and turning out thousands of graduates annually. In these schools are found teachers who stand high in ability. The product of these institutions consists of young men with a fair general training and considerable impracticable knowledge of one or more branches of engineering, coupled with a little mathematics and perhaps a reading knowledge of French or German. It has been the custom to grant young men having these qualifications degrees as engineers—civil, mechanical, electrical, as the case may be. They are turned loose upon the community at the rate of several thousand a year, the majority of them with their livings to make from the outset, and it is not usual at any time during their course of instruction for any information to be given them as to how best to take hold of this exceedingly practical problem, or how best to fit themselves for the exercise of an engineering profession.

At the moment technical education in the United States rests practically at this point. There are some manual training schools. They are too few in number and they are too limited by lack of funds and endowment to produce the best results. The country is a democracy and, probably as a consequence, young men seek the distinction conferred by membership in an engineering profession. But where are the schools that turn out the artisans—the men who work with their hands—the really productive factors in the nation's advance?

It is time to call attention to the harmful influence which purely professional schools have exerted upon the general community. Once, a generation ago, the apprentice system was in vogue in this country and the product of it is the splendid average of mechanical ability displayed by the artisans of these states to-day. This system, through the devices of labor unions, has been practically strangled, and to-day few or no recruits are added to the ranks of handicraftsman from this source. The son of the electrical worker, the iron-moulder, the pattern-maker or what not, is debarred from entering the shops as an apprentice to become in time as good a workman as his father, or a better one, and his ambitions lead him far too often

to progress from the public school to the technical institute and to adorn his name with the letters representing an engineering degree. The situation is in a certain way pitiful. In the making of an engineer without opportunity there is most often destroyed an artisan of capability. And the need of the country is certainly not for more engineers, but for more men with hands, brains and eyes trained to work skillfully together along certain lines of production—in short, for skilled artisans. Unless these are produced it is certain that succeeding generations will rise up and call us anything but blessed.

Mr. Andrew Carnegie, a man who is possessed of an abundant measure of common sense, has instituted at Pittsburgh a school for the training of artisans. There has been an immense amount of indiscriminate and unwise giving away of money in the United States in years past for the foundation of all sorts of schools, without any apparent reference to the future placing of the students who are receiving instruction in them. Mr. Carnegie will long be remembered for his miscellaneous benefactions, but it seems that in this particular instance he has spent money as wisely as it was possible to spend it, and that he will leave behind him an organization that will work more for the general good of his country than the purely professional schools which have been so largely founded of late. To give a young man the opportunity to earn a good living, to fill him full of the desire of accomplishment of a real kind, to put him out in the world equipped fully for the struggle for existence, is to make a good citizen.

We need the engineering schools, and their product is certain to reflect high credit upon the schools and upon the country; but greater than any possible need for such institutions is our lack of something to take the place of the apprentice system and turn us out men who can continue the splendid tradition of the American mechanic. Mr. Carnegie has doubtless foreseen this particular need, and his endowment of the Pittsburgh school for artisans is an evidence of the sound judgment which enabled him to accumulate the fortune he is so liberally spending for the benefit of his fellows.

CURRENT DISTRIBUTION.

Elsewhere in this issue the discussion on the subject of "Current Distribution in Metropolitan Areas," which was held at the last meeting of the American Institute of Electrical Engineers, is given with great fulness. It is a modern recrudescence of the old battle between the advocates of direct and alternating current for all sorts of purposes, and while, of course, it settles nothing, still it is interesting as showing the diversity of opinions that can still be held on so important a subject, and also as indicating the tendency to get together now shown in the two camps.

Perhaps the whole thing may best be summed up in the statement that one kind of current is good for one thing and the other kind for another, and that as one can be turned into the other at will the proper thing to do is to devise a system using both, in which each is applied to the best advantage. So long as there is nothing analogous to the storage battery for use with alternating current it seems that for distribution in the crowded central parts of large cities the direct current must hold its own. Again, the improvements lately made in incandescent lamps, by which lamps of high voltage are made with good commercial efficiency, has made possible the installation of such a system as that at Providence, R. I., showing excellent results over a wide distribution-area by the use of direct current.

Perhaps the price of polyphase motors has been one of the largest factors in holding back the general distribution of alternating current in our largest cities, because it is manifestly of great advantage to operate all forms of service from the same circuits and the same generating stations or substations. More and more as the price of real estate advances in our cities and buildings exhibit a tendency to soar skyward the elevator is becoming of importance, and so far the direct-current motor appears to have offered the best solution of the elevator problem.

But notwithstanding the remarkable advantages of direct current for this kind of distribution, the equally great advantages of alternating-current distribution have led the larger companies to substitute it for the other kind in most cases. Consolidations have played no unimportant part in the general progress of electrical distribution, and the tendency to gather together in large stations the machinery generating current both for lighting and railway supply is very marked. Perhaps the problem will take more definite shape when the alternating current is more fully exploited as a means for directly driving traction motors. For this, unfortunately, it seems as if we must wait for what our European colleagues are doing.

The discussion was very interesting and will well repay careful reading.

In this issue is concluded the long paper by Mr. L. B. Stillwell on the "Electric Transmission of Power from Niagara Falls." This interesting and important paper contains so much of value to the whole profession, and so clearly describes the vast complexity and difficulty of this record-making work of engineering, as to warrant its appearance in these pages *in extenso*. Its author is to be congratulated on having performed a service of value to his colleagues in presenting so fully the record of this signal achievement.

News comes that Mr. Guglielmo Marconi is on his way to Newfoundland to establish wireless telegraphy stations upon the storm-bound coast of that province. This is really good news. Cape Race, on the southeastern prolongation of Newfoundland, projects almost directly into the track of steamers bound between New York and the English Channel, and on account of the tempestuous weather and fogs which often prevail there has become a sort of marine graveyard. If wireless telegraphy did no other service than to establish a warning point on this dangerous promontory it would be a genuine blessing to maritime interests. It will make, however, in addition to this, a sort of half-way house of call, where ships can give and receive news, and will doubtless be found of considerable utility and advantage in many ways besides its capacity as an invisible beacon warning vessels of danger.

A Discussion of Electrical Distribution.

Papers and Discussions at the Recent Meeting of the American Institute of Electrical Engineers.

AS DESCRIBED in the last issue of the ELECTRICAL REVIEW, the one hundred and fifty-eighth meeting of the American Institute of Electrical Engineers, held on the evening of November 22, was a symposium on the important subject of electrical distribution in metropolitan areas. To some degree it was a renewal of the ancient controversy between the advocates of direct and alternating-current systems, but the novelty of some of the ideas presented, and the authoritative character of the participants, made the evening's programme one of great interest. The very large attendance of the meeting was a further evidence of the interest felt by members in the subject under discussion.

In opening the evening's proceedings, President C. P. Steinmetz said, in part:

"The problem of electric light and power distribution essentially consists in supplying electric power from one primary generating station to a number of customers in a form suitable for their demands. In its theoretical and simplest form a system of electrical distribution consists of the generating station and a system of distribution conductors and in addition thereto controlling apparatus from the generating station and metering appliances at the customers' premises. Stations of this simple form, but still of great magnitude, exist to-day in very large commercial operation. Since, however, electricity is required in many different forms it becomes necessary either to install separate distribution systems for these different forms or to introduce transforming apparatus into the system. By the introduction of transforming apparatus the generating system becomes more or less independent of the system of utilization and by this is created a problem for engineers to decide in every individual instance—which system of distribution is most suitable for the individual case. Under the circumstances it is not astonishing that different engineers of equal prominence may reach under individual conditions exactly opposite points of view, although naturally in many views a general agreement of opinion is found."

The first paper of the evening, of which a full abstract follows, was

"DISTRIBUTION OF ELECTRICAL ENERGY IN LARGE CITIES."

BY LOUIS A. FERGUSON.

With the trend of modern times toward consolidation of lighting, power and transportation properties, the system of distribution of electrical energy, in large cities especially, is daily becoming a more important question, involving many perplexing problems and considerations.

Nearly every city has granted franchises to many companies having varying degrees of financial and engineering ability, so that those who are ultimately engaged in consolidating the physical properties usually find it advisable to adapt their engineering to existing conditions, abandoning as little as possible of the investment made by those which they have absorbed. Not only must be considered what has been done in the past but also the possible development of the future, so that the remodeling shall not necessarily be that which might appeal most strongly to the conditions of the moment, but of the future; for our investments, let us hope, are made not only for the present, but for the future.

The developments of the last few years have determined conclusively that the old method of installing a multiplicity of steam generating stations scattered throughout the city and furnishing electricity for lighting and power in the surrounding district is no longer advisable. We find the more progressive companies abandoning their smaller plants as generating stations, converting some into substations and centralizing the generation of electrical energy in one or two large power stations located preferably on a water front and having direct communication with two or more railroads bringing coal from different sections of the country.

There are several instances in Europe, as well as in America, of lighting and railway companies providing for their future growth by the erection of large central power-houses of from 50,000 to 100,000 horse-power ultimate capacity. In some cases these new power-houses supplant entirely the older stations, and in others the older stations are retained intact, and are used during the peak hours of the winter months as auxiliary generating stations.

The choice of a site for the main power-house (water and coal facilities being equal in each case) will depend upon the combined cost of the land and the transmission of the total capacity to the substations with the advantage in favor of the site nearest to the point of greatest delivered output; that is, the preference should be given to that site where the value of the land forms a larger proportion of the total than does the cost of the transmission. The less the cost of the transmission the less its length, and therefore the less cable and conduit to maintain. Since the territory to be supplied in any large city from a central power-house for general distribution of electricity for all purposes is so extensive, the adoption of a high-pressure alternating current is necessary for transmission. There may be cases in which it is possible to obtain a site sufficiently large for a principal station near enough to the centre of greatest load to warrant the use of double-current generators if direct current forms the basis for lighting and power distribution, and the energy supplied for railway purposes is relatively small. In any new principal station the generators should be of the same frequency even if it is advisable, owing to local conditions, that one or more be double-current machines. It is always conducive to economy, flexibility of operation and minimum initial investment that all the generators be arranged for parallel operation. The installation of both 60 and 25-cycle generators in the same station in a large city should be avoided, as the greatest economy is only possible in a station generating by one class of apparatus.

The determination of the class of current we shall generate depends entirely on the class of current we distribute. Considering the question for a large city from the broadest standpoint and judging by experience with the advantages and limitations of both forms of distribution, I would recommend direct current for the lighting and power work of the strictly business and city residential districts, and alternating current for

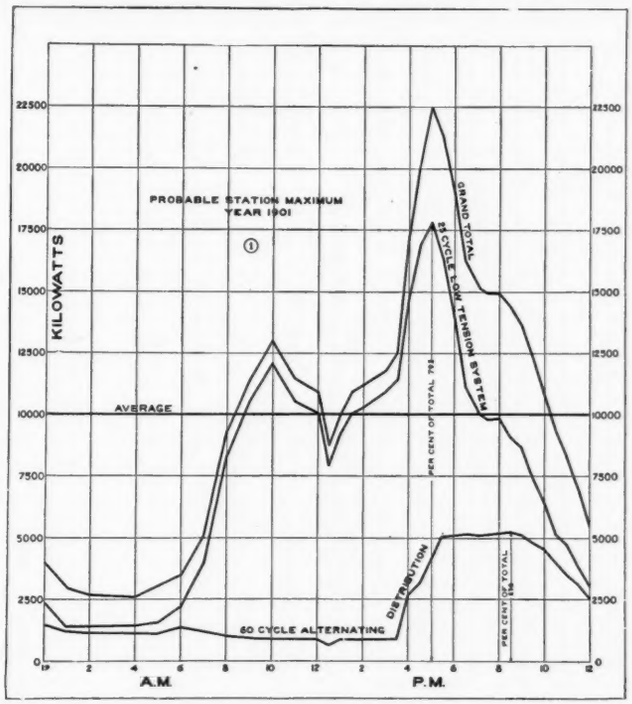


FIG. 1.—OUTPUT CURVE OF CHICAGO COMPANIES.

the less closely built residential districts, with their local business incident thereto, as well as for the actual suburban territory of the city.

An analysis of the lighting and power output (not including railways) of Chicago central station companies where this method of distribution is followed, may be interesting. Referring to Fig. 1 it will be seen that of a total maximum output of 22,500 kilowatts, 23.4 per cent is by 60-cycle alternating distribution over a territory of approximately fifty-eight square miles, and 79.5 per cent is by direct-current distribution over a territory of only ten square miles.

The output shown in Fig. 1 as 25-cycle low-tension distribution is largely generated at present by direct-current and double-current machines, as the principal generating station is only three-fifths of a mile from the largest substation. A considerable portion of this output will probably continue to be generated by the present low-tension direct-current and double-current machines even after a large 25-cycle alternating station is put in operation; but this curve is presented to show what portion of the entire load would be supplied by 25-cycle alternators and rotary converter substations, if an entirely new system were being constructed, the condition toward which we are developing.

The growth of the business of the company (except in the southern district, where a modern 60-cycle station operates) is being provided for by 25-cycle rotary substations and all direct-current generating apparatus will be superseded as it wears out or becomes obsolete by 25-cycle rotary substation distribution in one low-tension district. As the outlying residence districts become more general consumers of electricity, they are changed over to low-tension direct current, and all new development in the northern and western districts is supplied by motor-generator sets receiving 25-cycle current from the main generating station and delivering 60-cycle current to the distribution lines.

Reference to Fig. 2 will show how the maximum load of the low-tension direct-current distribution was provided for last winter. It will be noticed that the rotary converter output formed a very small portion of the total, but in this winter's maximum we expect to turn out about three times the amount of rotary output, while the direct current delivered to the distribution mains directly from the continuous-current generators will show only a slight increase. The storage battery discharge will show about 100 per cent increase. The growth in the rotary and battery outputs and the practical standstill in direct-current generating output give some conception of how we are working toward the idea of 25-cycle alternating supply from one large station to a number of combination rotary and battery substations. To effect a change of this kind without sacrificing the value and use of our present investment in direct-current generating stations will take several years.

In determining what shall be the general system of distribution, a study of the present conditions and future possibilities of electrical consumption must first be made, and the system chosen should be one that will best suit these conditions. Fig. 3 shows the relative quantities of light and power consumed monthly by the customers of the two Chicago companies. These curves represent only the actual power business for elevators and small factory use, and other general power for a large number of relatively small consumers, and do not include any street or elevated railway work whatever. It should be remembered, however, that any system of generating or supply which does not take into consideration this factor is not comprehensive enough to provide for the future conditions of our American cities, which will undoubtedly involve the supplying of electrical energy for lighting, general power and local transportation work from one or more large generating plants.

With the percentage of power as high as thirty per cent (shown in Fig. 3), even when general power only is included, the great importance of selecting a system of generation and distribution, which is well adapted for power as well as lighting supply, will be thoroughly appreciated. The feasibility of applying the direct-current motor to general power work is much superior to that of the alternating-current motor, and the disturbing effects on line pressures are less. The initial cost of the direct-current motors themselves and their attendant equipment is very much less; in fact, at the present time the selling prices of three-phase motors in America are far in excess of being reasonable. The direct current is also very much better adapted to electric elevator work than is alternating current; at the present time there is no alternating-current elevator equipment which could be considered fitted for first-class high-duty service, and the progress in development of an economical alternating-current elevator for any service is slow. The importance of the electric elevator to the central station company is shown by the diagrammatical representation of outputs. There it will be seen that the consumption of electrical energy by elevators alone is twelve and one-half per cent of the total output of the companies. Our ability to install an economical and successfully operating elevator equipment is frequently the deciding feature in the question involving the choice of central station service in preference to the installation of a private plant, and with its aid we are enabled in a large percentage of instances to show to the owners of large mercantile establishments and other buildings a decided saving by purchasing electrical service from the central station company for lighting, elevator and general power service when compared with the cost of operating an isolated plant using hydraulic elevators.

The development of the automobile and its extended use in the large cities have rendered necessary the installation of charging equipments at convenient points throughout the city.

The use of alternating current in the distribution system prohibits the use of storage batteries. Even assuming that the storage battery does not improve the economy of operating, still they are desirable wherever the service of the central station company is important. They may be adapted for use in various ways; in the central station itself when it is located at the electrical centre; at the centre of distribution for discharging during the peak; as auxiliaries in the rotary converter substations for discharge use at the time of maximum load in the main central station, or at any time of breakdown of the transmission line feeding the substation. They may also be used in substations in special districts where the load factor of the district is small, or midway between

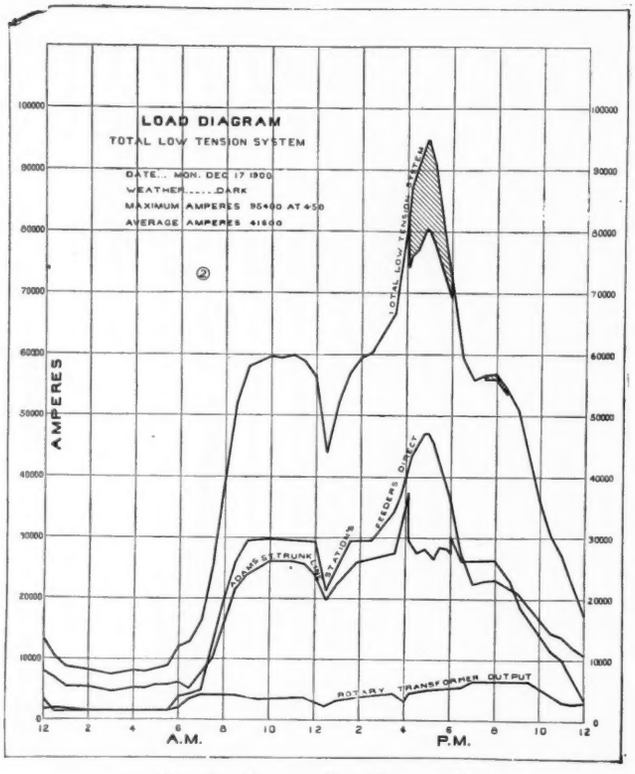


Fig. 2.—Chicago Low-Tension Output.

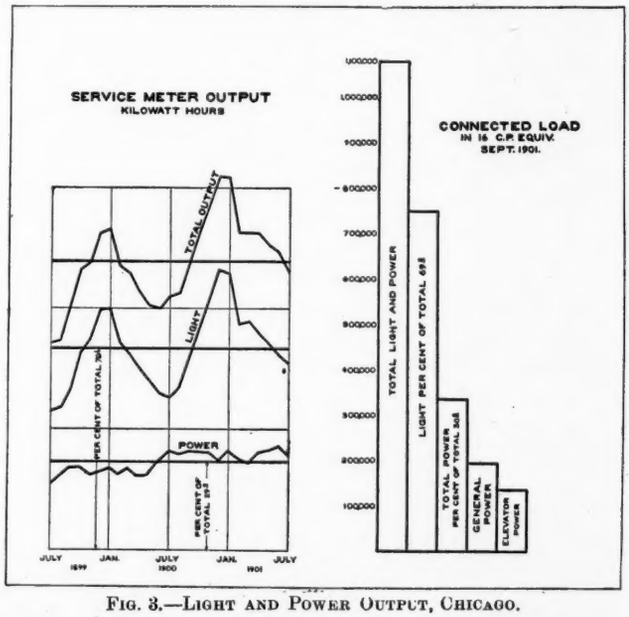


Fig. 3.—Light and Power Output, Chicago.

rotary substations for purposes of regulation.

The greatest value of the storage battery, however, is its ability to carry us through an emergency which comes as a rule in an electric lighting or power plant with very little warning. The fully charged battery kept constantly floating on the system becomes the watchdog of the company's service, responding to a call automatically, keeping the pressure chart perfect despite blown out cylinder heads in the central station or failures in substation transmission lines.

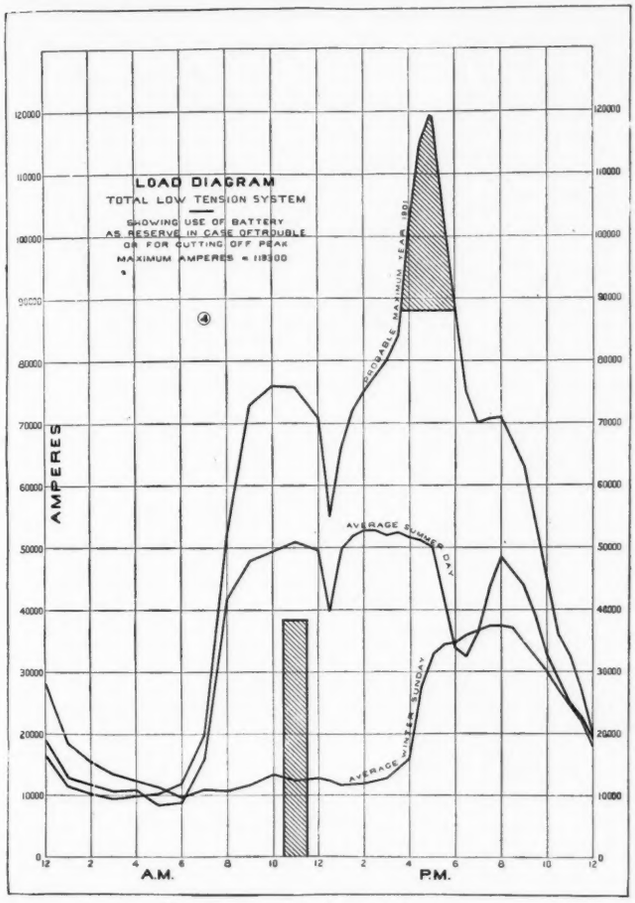


FIG. 4.—CHICAGO OUTPUT CURVES.

The storage battery has a very distinct value, which is seldom recognized and employed to its full advantage, when located at the central distributing point of a system with feeders radiating to various points in the network. The battery may be provided with two or more end-cell switches, so arranged that they may be connected in multiple and feed into the main distributing bus, or they may connect to one or more auxiliary bus-bars with a different number of cells in series, feeding into each bus and thus providing two or more potentials at the centre of distribution. It will be found that when only one pressure is maintained at the centre of distribution during the time of maximum load of a large district the pressure at the ends of the short feeders will be somewhat higher than the standard and they will be overloaded, and at the end of the long feeders the pressure will be lower and the feeders underloaded, although the pressure variation at other times may be negligible. Under such conditions the storage battery becomes exceedingly valuable.

Fig. 4 shows three curves, representing two extremes of daily output, one being the Sunday curve and the other the yearly maximum curve, and also a third curve, representing the form of the company's curve for about two-thirds of the year.

The rectangular crosshatched portion shows the capacity of the batteries at the one-hour rate of discharge and might be placed anywhere on the curve.

The upper crosshatched portion shows the use of the battery in cutting off the peak, thus saving an otherwise necessary investment in generating plant.

Occasions have arisen where through the bursting of a boiler tube the storage battery has saved the direct-current system from shutdown by carrying the entire load for about an hour, allowing time for cutting out the disabled boiler. It is impossible in this curve to show the value of the battery in maintaining even pressure throughout the system, but it is one of the very important uses of the battery.

The battery capacity of the Chicago Edison Company is distributed over the entire low-tension district. In addition to the three batteries in the Adams street substation, having a combined capacity at the eight-hour rate of 66,000 ampere-hours, there are smaller batteries in three of the rotary substations in the residence districts.

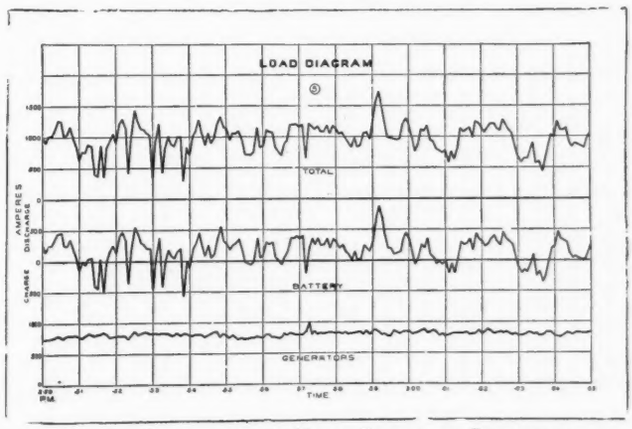


FIG. 5.—CURVES FROM A MOTOR-GENERATOR SUBSTATION.

These batteries in the residence districts, of course, can not economically cut off a residence load peak, because the latter is about four hours wide, but by discharging at the time of the down-town peak, which is only between one and two hours in width, they are able to cut down the demand for three-phase current at the generating station. In this way they are as valuable on peak work as though they were located in the down-town district, except that they do not save any investment in transmission line or substation apparatus.

Fig. 5 shows clearly the value of the storage battery in a motor-generator substation operating an interurban railway. Its main function here is as a regulating battery used to take up the fluctuations of the railway and keep a nearly constant load on the motor-generators.

Having determined that direct-current distribution is the most desirable for the central district of the city, and having shown that of the total maximum output of the lighting companies of the city, 79.5 per cent is by direct current, even when the promising sections of the whole city are well covered by mains, it then becomes natural to choose a system of generation for the principal stations that is best adapted to the direct-current distribution, as it represents such a large percentage of the total output. We, therefore, originally adopted in Chicago for transmitting to rotary converter substations 25-cycle three-phase alternating current generated by double-current machines at 160 volts alternating, arranged for stepping up to 4,500 and 9,000 volts. The reason for employing double-current generators in preference to three-phase alternators generating the line voltage was because the principal station of the company was only three-fifths of a mile from the point of greatest direct-current output. The double-current machine, therefore, could be worked at best efficiency supplying the necessary three-phase current for the outlying rotary substations, the balance of capacity in the generators being used to feed directly into the low-tension network, thus working the generators at all times at full load.

There has just been started in operation in this station the largest double-current machine which has yet been built. It has a nominal capacity of 2,500 kilowatts, with overload limit for peak work to 3,200 kilowatts, generating 300 volts direct current and 180 volts three-phase alternating. This machine is to run in parallel with the other double-current and direct-current machines in the station as well as in parallel with a new 3,500-kilowatt three-phase alternator being erected beside it to generate 9,000 volts.

As we have reached the limit of available space in our principal plants for the central district it is probable that all additional generating plants will be by 25-cycle three-phase alternators generating directly 9,000 volts, the transmission line voltage.

It is almost universally conceded that 25 cycles is the most desirable frequency for transmission and conversion by rotary converters. Sixty-cycle rotaries are considerably more expensive and much less satisfactory in their operation for the ordinary three-wire network, and still less satisfactory for 500-volt direct-current supply for surface or elevated railway service. Also for high-voltage underground transmission the lower frequency is preferable, inasmuch as the energy loss in transmission is less, and its resultant strain on underground cable insulation, whenever there is a slight disturbance on the system, is less troublesome. The kilowatt-hour efficiency of transmission and transformation between three-phase generators and rotary direct-current output for the entire substation system equals 82.2 per cent.

For all these districts a four-wire three-phase system from "Y" wound armatures supplied with the fourth terminal is used, the generator delivering a maximum of 4,150 volts, with 2,400 volts between the neutral point and any one of the outside terminals. There is thus available a voltage best suited for the single-phase lines in the immediate locality and the higher voltage for four-wire three-phase transmission to centres in more distant localities.

The general principles and systems which

have been here advocated as advisable for Chicago should be applicable to any large American city as the general conditions in all large cities are approximately the same. This, however, may not necessarily be true in the case of the smaller city or town as they are usually affected by some local conditions, and in some instances even the general conditions may not be such as to make the same system applicable.

The aim of every central station manager should be to strive for simplicity and interchangeability in his system of generation and distribution, avoiding as far as possible multiplicity and complexity of methods, building up a distribution system which shall be universal, thus standardizing the customers' appliances and apparatus throughout the city.

The next paper was read in abstract by its author, and is presented in brief extracts below:

"LOCATING FAULTS IN UNDERGROUND DISTRIBUTION SYSTEMS."

BY HENRY G. STOTT.

With the rapid and extensive growth of underground cable systems for the distribution of electricity for light and power purposes a problem of great practical importance has arisen, namely, to find a method of quickly and accurately locating a fault or ground in any part of the system.

With small conductors, such as those used for telegraph cable, the ordinary Blavier and loop tests with galvanometer, Wheatstone bridge and battery suffice; but the percentage of error in locating a fault varies directly with the cross-section of the conductor or inversely as the resistance. Any one familiar with the most refined methods of battery test will admit that the loop test is the best of all, as it eliminates the worst variable, namely, the fault resistance. Even under the best conditions the loop test has an element of uncertainty in the variation of the zero on the galvanometer due to earth currents getting into the cable through the fault. In a city, the source of this error becomes of greater importance than in submarine cables owing to the leakage of street railroad currents through the earth from the rails. As a matter of fact, it is frequently impossible to use a sensitive galvanometer on any test involving the use of the earth as a part of the circuit.

Loop tests carried out with the comparatively large current of ten amperes, using millivoltmeters instead of reflecting galvanometers in the hope that the stray currents would thus become such a small percentage of the test current that the errors due to the presence of the former would be practically eliminated, also failed entirely, and the conclusion was reluctantly reached that the galvanometer and battery must be abandoned whenever the resistance to be determined was less than 0.25 ohm.

The distance between manholes is evidently the practical degree of accuracy essential to any successful method. This will average about 350 feet. Assuming that 0.25 ohm is the limit of accuracy obtainable under these conditions, in the loop test this means that the method is not applicable to any conductor larger than No. 9 B. & S. gauge, and therefore of no practical value for lighting and power purposes.

Resistance measurements having been eliminated as a possible means of solution, there remains three others, which may be called:

(*a*) "The cut-and-try method."
(*b*) "The smoke method."
(*c*) "The compass method."

(*a*) The "cut-and-try method" is too well known and too bad to merit much description, as it simply means cutting the cable into as many sections as necessary until the fault is finally located in a length between manholes.

(*b*) The "smoke method" is also crude, and simply consists of putting a current of sufficient magnitude into the cable through the fault, to cause the insulation to burn and give out volumes of smoke, by means of which the location of the burnt section may be discovered upon opening up the manholes.

(*c*) The "compass method" is, in the writer's opinion, the only practical and safe means of quickly and accurately locating a ground in cables larger than No. 9 B. & S. gauge. This method consists, briefly, in sending a constant continuous current of about ten amperes into the cable through the ground, the current first passing into an automatic reverser, which reverses the direction of the current flow every ten seconds. A manhole is then opened near the centre of the cable length and a pocket compass laid on the lead sheathing of the faulty cable and observed for, say, half a minute. If the ground is further from the source of reversed current, the compass needle will swing around approximately 180 degrees upon every reversal at the end of each ten seconds' interval. The manhole is immediately closed and another opened, say, a mile further away from the source of test current, and if no motion of the compass needle occurs, then the fault has been passed and another manhole is opened between the two first positions, and so on until the fault is finally located in a section between two manholes.

It will be observed that by this method (1) the cable is not cut, thus causing no delay or expense in rejointing; (2) the number of manholes opened is a minimum, and the time spent in each is only about one minute; (3) the amount of current used is so small that no arcing or burning occurs and no explosions.

One form of reverser used by the Manhattan Railway Company, consists of a one-quarter horse-power three-phase induction motor, geared to a two-part commutator, which revolves in oil in order to ensure the quick reversal of current without danger of arcing across between segments. An ordinary constant continuous-current arc light machine is the most convenient source of current for this test, as it will supply a constant current throughout a wide range of voltage, thus automatically adjusting itself to the varying fault resistance. Should an arc light machine not be at hand, 500-volt current can be used through a resistance and reverser.

Before putting on the reversed current it is advisable to break down the fault resistance by the application of a high-potential testing transformer to the cable for a few seconds.

This method of test is especially useful in any network of cables, such as 2,200-volt single, two or three-phase mains and feeders, as the test current can be run on the network, without shutting down the supply service or interfering with it in any way, by simply sending the ten-ampere reversed current through a reactive coil (or the primary of a transformer) before entering the grounded main. This is merely done to protect the arc light generator in case another ground should develop and thus cause a short-circuit on the alternating-current generator. This method of testing live circuits is only applicable, of course, to those supplying alternating current and having no permanent ground attached.

After using this method of locating faults for four years, the writer can not recall any case, in which the method was properly applied, that required more than three hours to locate a fault in cables having a length of from four to six miles. The whole secret of this rapidity lies in the fact that the first test at the centre of the line eliminates one-half of the cable from the question. To find a fault in a duct between manholes in a similar length of cable, by any other method known to the writer, may easily take two days, and as many more may be required to repair the cuts.

An interesting description of methods in use in a very important high-tension distribution followed, and is here abstracted:

"THE BUFFALO HIGH-TENSION CABLE DISTRIBUTION SYSTEM."

BY HAROLD W. BUCK.

In the development of the electrical transmission of power many propositions are being presented of a water power or coal mine situated within such a distance of a city that it is cheaper to transmit power from the mine or waterfall than to generate it by steam in the city itself. In such systems

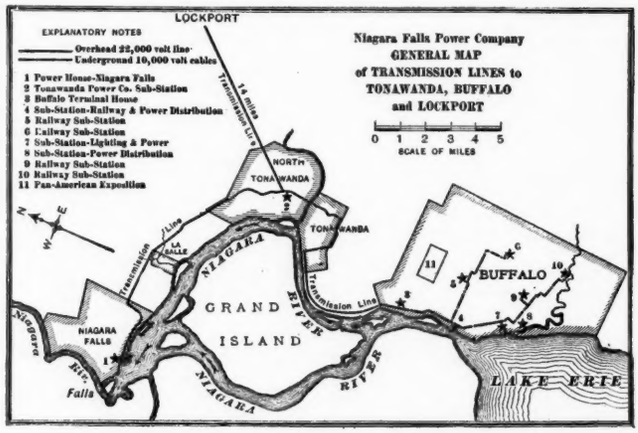


FIG. 1.—MAP OF THE NIAGARA-BUFFALO LINE.

three engineering elements must be considered: First, the generating plant; second, the transmission line, and third, the method for distributing the power at the end of the transmission line. Electrical generating plants and transmission lines have been the subject of many discussions, but the terminal arrangements for transmission lines are newer in their development, and it is the object of this paper to bring the matter up before the members of the Institute for discussion, the problem presented being the best method of distributing the power throughout a city after a point has been reached on the transmission line where it is no longer safe to carry the power overhead at the transmission voltage. Such limitations exist on the outskirts of all cities.

In order to serve as a basis for discussion and to point out the various considerations which enter, a brief description will be given of the method which has been adopted for the distribution of Niagara power in Buffalo.

Fig. 1 shows a map of the Niagara-Buffalo transmission line indicating the relations between the overhead circuit and the circuits of distribution within the Buffalo city limits the numeral 3 on the map indicating the terminus of the 22,000-volt overhead three-phase lines. At this point the three overhead circuits, each having a capacity of 10,000 horse-power at seven per cent line loss, enter a terminal house, and are connected to the primaries of the step-down transformers. These transformers have a capacity of 3,000 horse-power each, and are

of the oil-water cooled type. The secondaries of the transformers are wound for 11,000 volts, making the ratio of reduction of voltage 2.1. The secondaries of the transformers are connected through selector switches and two sets of bus-bars to the underground cables, each of which is connected through an air-break circuit-breaker. With the arrangement shown, the Buffalo system can be operated in two sections if desired, and any overhead circuit or any cable connected to either of the banks of transformers. The 11,000-volt cables supplied from the secondaries of the terminal house transformers are drawn through tile ducts under the streets in the usual manner, and carry the power to the various substations throughout the city of Buffalo. At present there are five feeders, each consisting of No. 000 triple conductor lead-covered cables. Two

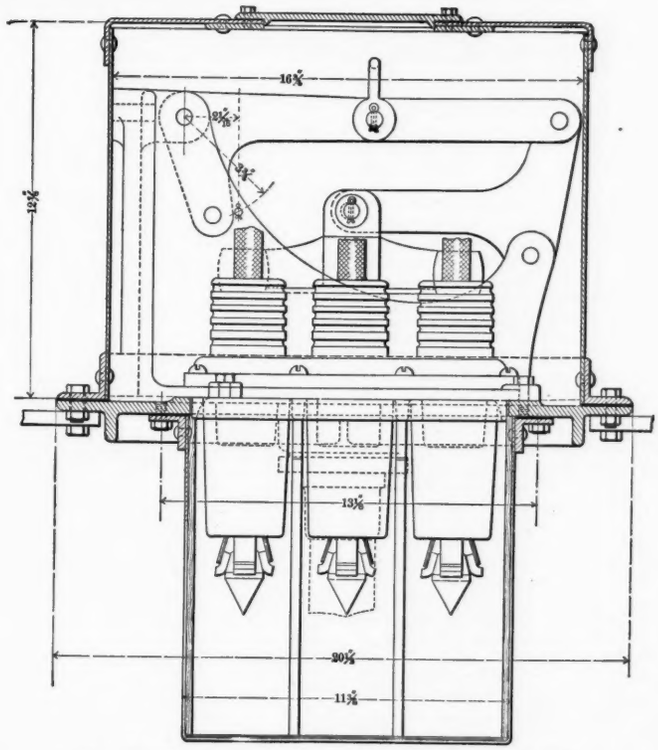


FIG. 2.—UNDERGROUND THREE-PHASE SECTION SWITCH.

of these have 9|32 inch rubber, two 8|32 inch rubber and one 6½|32 inches paper and 4|32 inch paper over-all. The lead in all cases is ⅛ inch thick.

Special attention is called to the section switches, which are shown in Fig. 2. They are of the triple-pole, single-throw type of oil-break switch, with a water-proof hood of iron bolted to the top of the switch frame for the protection of cable heads and leads. These switches are installed in vaults under the city streets, placed at convenient intervals. Some of the vaults are as large as 10 feet by 12 feet. The switches are absolutely water-proof and could be submerged if necessary without danger, and will open the circuits under heavy loads without difficulty. They have proved of great convenience at times when repairs have been necessary on sections of the cables, and for locating faults without the necessity of cutting the cable. I believe that underground section switches of this kind would prove of great service to all high-tension cable systems, and believe that the design shown is entirely safe for service at 11,000 volts.

In all, seven substations are supplied with power at 11,000 volts, three-phase, distributed as follows:

Station No. 4—2,000 horse-power, for railway purposes, transformed from 11,000 volts to 360 volts and fed to four 500-horse-power rotary converters. 1,000 horse-power, for general power distribution on a tertiary system at 2,200 volts, three-phase, the voltage being lowered from 11,000 volts by three 250-kilowatt transformers. This 2,200-volt distribution is partly overhead and partly underground.

Station No. 5—1,500 horse-power, for railway purposes, transformed from 11,000 volts to 360 volts and fed to three 500-horse-power rotary converters.

Station No. 6—1,000 horse-power, for railway service, as in Station No. 5.

Station No. 7—5,000 horse-power is transformed from 11,000 volts to 360 volts and fed to the plant of the Buffalo Lighting Company in an adjacent building. 1,000 horse-power, transformed to 2,200 volts, three-phase, for general power distribution on the tertiary system.

Station No. 8—2,000 horse-power, transformed from 11,000 volts to 2,200 volts, three-phase, for power distribution on the tertiary system.

Station No. 9—1,500 horse-power, transformed from 11,000 volts to 360 volts, for supplying power to three 500-horse-power rotary converters for railway purposes.

Station No. 10—1,000 horse-power, for railway purposes, as in Station No. 9.

It might be asked why the power is not transmitted from Niagara Falls at 11,000 volts and distributed through the underground cables without transformation. It will be found, however, that the saving in copper on the transmission lines by the use of 22,000 volts more than pays for the transformer installation in the terminal house, and that the saving in line loss is greater than the loss introduced by the step-down transformers. The longer the transmission line the greater would be the proportionate saving. It may also be asked why, if the overhead lines are to be operated at 22,000 volts, the transmission can not continue at this voltage throughout the cable system in order to avoid the use of step-down transformers. It is true that there have been examples of successful operation of underground cables at voltages even higher than 22,000 volts, notably the transmission from the plant of the St. Croix Power Company, but, obviously, what can be done on a through trunk line can not be safely done on a network, and the Buffalo underground system is essentially a network. It has many lateral connections, frequent joints, section switches, cable heads and switchboard connections, and under these conditions, which are probably no different from the requirements of other cities, I believe that 11,000 volts is, in the present state of the art at least, the highest voltage which should be considered. The success of the Buffalo power distribution at 11,000 volts, which has covered a period of about four years, has, however, demonstrated the safety and feasibility of using a potential as high as this, provided the greatest precautions are taken in the selection and installation of cables, and in the insulation of all terminal appliances. It seems to show that there is no longer any reason for fixing the prevailing voltage of 6,600 volts as the safe limit for underground work and for paying for the extra copper and ducts required by the lower voltage.

In cases of short-circuit in the cables, practically no damage is done at 11,000 volts on account of the small current. Short-circuits have occurred on these cables, which have had the whole of Niagara power back of them, and it has been found, after locating the fault, that the lead was barely melted off around the fault. At 6,600 volts such a short-circuit would undoubtedly blow the cables to pieces, on account of the greater current, the heat energy at the fault being nearly four times as great. This is a practical advantage, for it reduces the risk of damage to adjacent cables and ducts.

In the city of Buffalo, then, we find a distributing company called the Cataract Power and Conduit Company purchasing power from the Niagara Falls Power Company at the Buffalo city line, at the transmission voltage, lowering it to 11,000 volts, three-phase, 25 cycles, and distributing it as raw material in this form as dealers in power. To the railway company it is delivered for transformation and conversion for use on their own direct-current circuits, to the lighting company for conversion into the various forms in which they redistribute it to small consumers, and it is also delivered to various factories using power in quantities from seventy-five horse-power and upward, to which consumers' power is supplied from the tertiary system mentioned at 2,200 volts, three-phase, from substations owned and operated by the Cataract Power and Conduit Company.

From a business as well as an engineering standpoint it is believed that the methods used in Buffalo as described are very satisfactory and economical.

The transformation of voltage at the city line from 22,000 volts to 11,000 volts, besides being necessary, is also a positive engineering advantage, for the reason that it renders the 11,000-volt cable system independent of "grounds," and high-voltage disturbances from lightning, resonance, etc., which occur at times on the transmission line, since there is no electrical connection between the two. Although there have been several instances of rises of potentials on the overhead line far above the normal, resulting probably from resonance, no rises of voltage have been noted as having been transmitted to the cables by induction through the cores of the step-down transformers.

It is believed that the methods here described are practicable and convenient, and can be safely followed in principle by those who are planning similar systems of distribution.

The next paper is given below in full:

"ALTERNATING CURRENT AS A FACTOR IN GENERAL DISTRIBUTION FOR LIGHT AND POWER."

BY CHARLES F. SCOTT.

The foregoing title immediately suggests the old-time controversy, alternating *versus*

direct current. The present problem, however, may be more accurately stated, alternating current only *versus* alternating current and direct current.

The economical radius of direct-current supply from a central station is so limited that even in a strictly direct-current system, if it covers considerable area, recent engineering prescribes a large alternating-current generating plant furnishing power to rotary converter substations, and from these the direct current is distributed. This is witnessed in recent installations in greater New York.

The problem therefore is this. For general distribution for lighting and power service where the current is generated in alternators is it desirable to utilize the current as alternating current or to convert it into direct current?

Before taking up in detail the various elements involved, the following statements may in general be considered as axiomatic.

(1) Simplicity demands a uniform system with elements as few as possible and requiring a minimum of attention. Converting apparatus requires rotating machinery and the presence of attendants, and these involve first cost, operating expense, complication and liability to interruption of service.

(2) In classes of service for which direct current possesses no advantage over alternating current conversion is undesirable. For example, the simplest case is incandescent lighting. It is doubtful whether any one would propose converting to direct current if incandescent lighting alone is to be supplied.

(3) In outlying districts or other territory where the output from a substation would be quite small, it would obviously not be economical to convert into direct current as many of the expenses of such a substation would be relatively large, so that the cost per kilowatt for converting into direct current would be excessive.

These conditions limit the general problem, and the question may now be stated thus: In those cases in which the conversion from alternating into direct current is commercially practicable, is it necessary or desirable?

It will be readily granted that usually a large part of the service would be as satisfactory if operated by alternating as by direct current. With regard, then, to those elements in which there is a difference of opinion, are the reasons for the use of direct current sufficient to justify the increased complications and expense of the converting apparatus?

To answer this intelligently we will consider it in two divisions:

(*a*) In the utilization of electric energy what advantages has direct current over alternating current?

(*b*) When energy is generated as alternating current what disadvantages are involved in utilizing it as direct current?

Taking up the first of these let us consider the ordinary classes of service and the means of providing for them.

Incandescent lighting may be considered as indifferent to the character of the current whether it is alternating or direct, provided the frequency be sufficiently high to prevent flickering.

Arc lighting is most extensively carried on by the enclosed arc lamp which is satisfactorily operated from direct-current circuits, and also from 60-cycle alternating circuits, so that there is no compelling reason for choosing either one current or the other as far as arc lamps are concerned.

The Nernst lamp which is quite satisfactory in its operation on alternating current but not on direct current, gives a positive reason for choosing the former.

In discussing motor service it is not the intention here to enter into a controversy as to the relative merits of alternating and direct-current motors. Suffice it to say that both are in extensive use for nearly every kind of service. The induction motor is notable in having no commutator, and on account of its ability to stand various kinds of abuse. It is especially fitted for general distribution of power in all sorts of places as such motors receive little or no attention.

For constant speed work probably no one will question the superiority of the alternating-current motor from the standpoint of the man who uses the motor and pays for repairs. Any objections which may be brought forward will probably be urged on account of reasons applying to the supply system such as power factor, starting current and voltage regulation. These items may be provided for by properly designing the system, and they can not be regarded as legitimate objections to the use of the alternating-current motor.

For variable speed work the conditions are different; the fundamental difference is due to the fact that although there is a close correspondence between the performance of the induction motor and the direct-current shunt motor with constant field excitation the alternating-current motor does not have an exact analogue to the direct-current series motor. It follows that induction motors can not exactly duplicate all direct-current motors. Therefore the results which may be desired must often be obtained in a different way from the methods employed with direct-current motors.

From the above summary it appears that all of the important classes of service for which current from a central station is used may be successfully undertaken either by the direct current or by the alternating current, sometimes equally well, sometimes with the advantage on one side and sometimes with the advantage on the other side. The most important difference is probably in the case of variable speed motors and the importance of this will depend quite largely on the proportion of this kind of service. Although the alternating-current motor can not exactly replace the direct-current motor, so that there may be some inconvenience in changing from one system to the other, yet when a new plant is being laid out, it is probable that the cases are very rare in which it would not on the whole be practicable to utilize either alternating-current motors or direct-current motors.

To consider next the apparatus employed for producing and distributing current, the elements in the two systems may be set forth as follows:

Alternating Current only—Alternators, switchboards, primary mains, transformers and distributing circuits.

Alternating and Direct Current—Alternators, switchboards, primary mains, substations with switchboards, transformers, switchboards, rotary converters, switchboards and distributing circuits.

Comparing these in detail, the generating station in general will be substantially the same for the two systems, although a higher frequency will usually be employed if there is little or no conversion to direct current.

The primary feeding system will also be substantially the same in the two cases, differing, however, in the number of points at which the transformation is made to the low voltage, and the distributing system is supplied with current.

The substations for conversion into direct current constitute the great difference between the two systems. Substations with converting apparatus are expensive to install and to operate. The cost of the substation naturally makes it desirable to have as few as possible, hence they are located at as great a distance apart as the distributing circuits will permit.

The cost of distributing circuits for direct current is therefore very much greater than for the low-tension alternating-current circuits to which current is supplied from a large number of transforming points since the alternating-current circuits are comparatively short, and the cost of copper is hence greatly reduced. This effects a saving not only in the cost of the conductors themselves but also in subways and ducts, which are often limited in capacity, and high in cost.

The liability to accident and interruption to service is inevitably greater in the system which converts to direct current than in that which merely transforms to a lower voltage since the substation with its switchboards and rotating machinery intervenes between the generator and the customer.

The storage battery is an element which is sometimes presented as a reason for adopting direct current, as it may be readily added to the system. It may, however, be used in connection with alternating-current distribution. A rotary converter may be employed for charging the storage battery, and in turn the battery can supply current through the converter to the alternating circuits. In this manner the battery may be related to the alternating system in substantially the same way that it is usually related to the direct-current system except that the converter is between the battery and the service.

The foregoing general comparison between the two generating and distributing systems evidently favors the one which employs alternating current only. The introduction of converting apparatus therefore must be justified by advantages accruing in connection with the utilization of the current which are sufficiently great to overbalance the extra cost and complication.

To change an existing direct-current system into an alternating-current system is in many cases a difficult matter. The circuits which are suitable for direct current may not be suited for alternating current. The motors used for the direct current would of course be useless on the alternating circuits. These and other similar points complicate the general problem, and when an existing direct-current plant is to form part of a large system, such considerations often determine the plan to be followed.

The foregoing discussion applies particularly to large city plants for supplying lights and stationary motors for general work, and it has been assumed that the entire service is supplied either by direct current or by alternating current. There are, however, some cases where a combined service is advantageous, alternating current being supplied for certain districts, and direct current for others.

In cities, a combined service for general distribution is sometimes applicable for furnishing direct current from substations to districts which have previously been supplied by direct-current generating plants, while alternating current is furnished to the outlying parts. The same generators may be used for both classes of service, and may supply them simultaneously. Quite similar results may be attained from a direct-current generating plant, the alternating current being obtained from inverted rotary converters.

In smaller towns a combined service from an alternating-current plant is often used for supplying railways by 60-cycle rotary converters in connection with general lighting and power, the latter service being entirely by alternating current. In many cases the lighting and railway work can be operated from the same bus-bars, as the automatic compounding of the rotary converters is such as to make the voltage upon the general system sufficiently constant for lighting service.

Probably the most pertinent conclusion to be drawn from a discussion of this kind is that there is no ideal system, and no panacea plan which can be universally applied. Existing and local conditions, special requirements and the relative importance of the various classes of service to be rendered must all be taken into account in determining what will be adequate in an individual case.

The systems which we have been discussing have an important and far-reaching influence upon industrial life and social activity aside from their engineering aspects. It would be difficult to find an agent

more instrumental in bringing about the unification and concentration of diversified industries and interests than electric energy in the form of alternating current.

The recent electrical development in greater New York demonstrates this on a magnificent scale. A generation ago it would have defied the imagination to discover any natural connection between such widely different agents as horses pulling street cars, locomotives drawing elevated trains, gas lighting houses and streets, water operating elevators, stoves heating and cooking, and engines of every sort and class doing a hundred kinds of work. But all of these and many others are in common being superseded by the electric current, which does not merely replace but develops, expands and transforms. It is notable that all of this varied service is to be supplied from alternating-current generators; also that the outcome of the evolution of plans for general distribution and for railway work is identical in that alternators of the same frequency are being installed for both, so all could supply current to a common universal system.

Mr. Scott's paper was followed by

"NOTES ON THE ALTERNATING-CURRENT SYSTEM OF DISTRIBUTION."

BY W. S. BARSTOW.

Distributing systems are usually referred to under two headings—direct and alternating.

The direct-current distributing system, starting in the early '80's and appearing generally in its three-wire form, is what may be termed a universal system, since from the same conductors, and without any modification whatever at the customer's service, current is furnished direct to any electrical apparatus, whether for supply of power, light or heat.

The alternating-current distributing system, making its appearance in its single-phase form about the same time as the direct, never started as a means of universal supply, being confined in its earliest stages of development to the furnishing of energy for light and heat only. To the absence of the alternating-current motor can probably be traced its restricted use and the early slow progress in this form of current supply. Had there been early developed a single-phase motor which would have met all the conditions of a direct-current motor in construction, economy and cost, then there is no doubt but that the three-wire, single-phase alternating-current system would have come rapidly to the front. As to whether it would take the place at the present time of large installations of direct-current supply, might perhaps be doubtful, since the storage battery as a part of the general system is gaining ground and rapidly becoming indispensable.

The alternating-current distributing system was first exploded as a house-to-house supply, and continued as such until within recent years, when efforts were made to interconnect the secondaries to increase the efficiency and reliability of the system. It was soon found, however, that the paralleling of transformers in old systems already erected, through small secondary mains, was much like paralleling compound generators through a small equalizing bus, and many failures were the result. The only practical and successful method of paralleling transformers on secondary mains of distribution is the placing of each transformer or bank of transformers on a separate feeder and providing at the station means for regulation on such feeder, so as to make it possible to divide up the load on the different transformers and compensate for any difference in transformer regulation. Such a system is in successful operation in several large plants, and is productive of good results. When the alternating-current system is permanently standardized the transformer will no doubt be considered a part of the feeder, only one transformer or bank of transformers being installed at a single distributing point of a single feeder.

Up to the time of the appearance of the multiphase motor the development of motor business on alternating systems was very restricted, as the uses to which the single-phase motor could be put were more or less limited. On the other hand, the introduction of the multiphase motor necessitated a change in the entire system of distribution, and it is not until the last few years that single-phase has entirely given place to multiphase systems, not, in fact, until it became apparent that the multiphase motor, under any stage of development, would prove superior to the single-phase. Probably the simplest multiphase alternating-current distributing system which would be first thought of would be the two-phase, three-wire primary and three-wire secondary. Such a system might be satisfactory where light only is used and where the middle wire of the secondary system is always kept of proper size to maintain the balance, but there is no doubt that the better commercial form is the four-wire secondary, or in fact, the two phases taken directly from the machine to the customer's service. With the same number of conductors, a further saving of copper is secured by the use of the four-wire three-phase. With either of these systems, where transformers are a part of the individual feeder, a complete interconnection of mains can be secured. When the supply from these secondary mains is introduced into the premises of the customer, necessity for installation of additional transforming apparatus arises. If the secondary be of a pressure of 110 volts between phases, either large motors must be installed at this pressure or step-up transformers used. In either case the mains must be very large to take care of this low-pressure motor current, and especially when such multiphase motors are frequently stopped and started. If the secondary be of a pressure of 220 volts, the size of conductors can of course be reduced, but it is still necessary to install a transformer or balancing device if 110-volt arc or incandescent lamps are used.

With the object of simplifying the system, in many cases the multiple network of secondary mains has been omitted, and in their place a multiple network of primary mains substituted, the transformers being located on the premises of the customers. This reduces the system to a house-to-house supply and makes necessary the building of vaults or in other ways satisfying the insurance companies, as the full pressure is introduced into the premises of the customer. Such an arrangement necessitates an increase in the transformer capacity of the system, since the capacity of the transformers must be nearer the capacity of the connected load, whereas if grouped and the supply furnished through secondary mains, the transformer capacity can approach nearer the actual maximum load of the system.

In order to reduce the fluctuations of pressure in the lighting circuit, caused by large direct-connected alternating-current motors stopping and starting, there have been devised several systems which provide separate means of supply for motors and for lights, by providing additional "power" conductors, but in nearly all cases such systems necessitate the installation of primary transformers on the premises of the customer. With a view of furnishing a single service to the customer without installing apparatus on the premises, there are one or two systems employing four or five low-tension conductors in the secondary, from which different combinations of pressure are secured for the separate operation of motors and lights, but such systems have not been put to extended central station use.

But if the alternating system has not yet attained the standard of a large distributing system for compact territory, it is nevertheless alone in its field of transmission and house-to-house supply in scattered territory, and yet even in these fields too much attention can not be paid to the consideration of future permanent supply, there being many cases of its having been used as a very temporary means of "getting there." A generator is bought, a few miles of small-sized conductors erected, enough transformer capacity installed to supply the present wants, and the installation is complete and trouble begins. When extra transformers are required, they are purchased one by one in small sizes and connected to feeders already too small to carry the load. The idea of a change in the size of conductors never occurs, and soon the station manager does not think much of the alternating system and by that time the public generally agrees with him. This state of conditions is due to the fact that the system has not been designed with an idea of permanency, and the future and uncalculated demand upon it completely destroys its usefulness. Such a state of affairs existed in the pioneer days of direct-current engineering, the future demands seldom receiving the consideration which they warranted. Inspectors "determined" the system and visited every corner of the city, every private house, hotel, etc., and finally "determined" that the heaviest direct-current mains in the business section should be 27,000 c. m. and the feeder 41,000 c. m. Three years later, in the same city, these mains were replaced by others of eight times the capacity, and were even then too small. Such was true of the simple direct-current system, and it was even more true of the alternating system. The idea that the alternating high-pressure system saves copper, and that therefore it may be possible to save it all, has often brought about a final failure of a promising success.

What is required to-day, however, if the alternating current, besides retaining its field of transmission and scattered distribution where it is supreme, would enter the compact direct-current field of distribution, is:

First—A standard type of motor, which can be used for all classes of business demand and will meet the same commercial requirements as the present direct-current motor.

Second—A universal system of supply, which does not require transformers, etc., or anything outside of the meter itself, to be located on the premises of the customers.

Third—Some apparatus which, in connection with alternating current, will take the place of the storage battery supply on the direct current.

With these requirements complied with, the alternating-current distributing systems can expect to take the place of many of the large direct-current systems, not only for the supplying of light, heat and power, but also for transportation.

The last paper presented was the following:

"250-500-VOLT THREE-WIRE DISTRIBUTION FOR LIGHTING AND POWER."

BY PHILIPPO TORCHIO.

In the last few years great improvements have been made in the manufacture and selection of incandescent lamps. The arc lamp practice has undergone a radical change. The wiring and appliances connected with electric installations of buildings and other places have been brought up to a high standard of good workmanship and insulation. These, and other not less important improvements have made possible the use of commercial voltages considerably higher than were permitted in the early stages of the industry of electric lighting and power distribution.

In existing well-developed systems of low-tension current distribution it would be out of the question to consider at this date the proposition of changing the voltage of the existing systems, but on new installations and in places where changes of systems of

distribution are contemplated it is sometimes convenient to adopt the three-wire 500-volt system which has met with great favor abroad and especially in England, and which is gradually being introduced in this country. In its favor are the following points:

The system has all the advantages of the original low-tension Edison three-wire system, and it has greater capabilities of expansion in lightly loaded or scattered territories as is often the case in small cities or in large factories and other places. The system is economical to operate, it is economical as to distribution within a wide radius, it is flexible and easy of control and simple of operation, and free from such troubles as capacity and inductive effects which appear on alternating-current transmission lines and translating devices; it can be applied directly to a greater variety of services than any other system, and finally it derives from the use of the storage battery economical advantages in station investment and the invaluable commercial superiority of ensuring continuity of service.

The generating equipment and the station apparatus for 500-volt systems is just as well developed as any other apparatus on the market, and the cost is well in line with other standard apparatus.

The main unfavorable points of the 500-volt three-wire system are (*a*) the increased tendency to arc, necessitating the use of wiring and appliances of high insulation and carefully separated terminals at the customers' installation, (*b*) the lower efficiency of the 250-volt incandescent lamps as compared with lamps of half that voltage, (*c*) the difficulty of operating 250-volt arc lamps.

These limitations are gradually becoming less and less restrictive, as a review of the present conditions will demonstrate.

As to the insulation requirements for wiring and appliances, the new rules of the National Board of Underwriters prescribe the same insulation and breakdown test for all wires used with voltages between 0 and 600; all lamp sockets and receptacles must be suitable for use on any voltage up to 250 volts, only rosettes, cleats, knife and snap switches, etc., are required to be special for voltages between 250 and 600. In general, it may be said that any modern installation will safely withstand a 500-volt service, and that the conservative requirements of the Board of Fire Underwriters are not uncommercially stringent. It may, however, be said that not all the local Boards of Fire Underwriters have as yet adopted the rules of the National Board.

In regard to efficiency of high-voltage incandescent lamps, the difference for the standard 16-candle-power lamp of same candle-hour area as the low-voltage lamp is about ten per cent. The best 200-250-volt 16-candle-power lamps made at present have an initial efficiency of 3.4 watts per candle, and have the same life as the 3.1 watts per candle 110-125-volt lamp.

In large cities supplied by Edison system, the common practice is to use lamps of 3.1 watts per candle; in all other places, lower efficiency lamps are ordinarily used, and the 3.6 watts per candle lamp is quite common. In the latter case the adoption of a 3.4-3.5 W. P. C. 250-volt lamp would not materially overtax the user, nor the illuminating company, and, therefore, for such places the 500-volt three-wire system would not be at a disadvantage on that account.

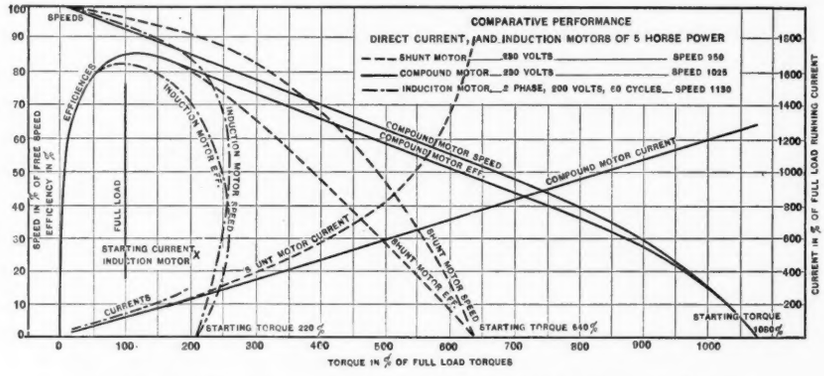
The difficulty of adapting arc lamps to the 500-volt three-wire system has been overcome by connecting two ordinary enclosed arc lamps in series in the same manner that the old open arcs were, and are still, in many places, connected on the 110-volt circuits. Lately, however, several types of double arc lamps have been used with entire success. The single arc has also been tried to some extent, but it has proved a failure for general use on account of the objectionable blue light it gives. Such lamps are, however, used for street lighting in a few places.

The review of the difficulties to be overcome shows that they are not very serious, especially for new installations and where changes of distribution are contemplated.

The discussion was opened by Mr. Gano S. Dunn, who took up the points in Mr. Scott's paper, especially the statement that the induction motor is to some degree an analogue of the shunt motor.

In the first place, this analogue is limited to a shunt machine with constant field excitation. By that limitation, Mr. Dunn thought, was really overlooked one of the principal advantages of the shunt motor, which is the possibility of controlling its speed by controlling its field. To this, he pointed out, there is no corresponding analogue in the induction motor. The second point in which the analogue fails is that the speed of the induction mottor can not in any wise be changed by varying the voltage upon its armature. This matter of speed control, he thought, far from being an insignificant element, is very important, and we must not think that in future we shall be contented with constant speed simply because we have been accustomed to it in the past. Multiple-voltage systems are coming into wide use and only direct-current motors can be used with success on such systems. A four-wire system can give six fundamental speeds and by modification of these by variation of field strength, or the use of a little armature resistance, twelve speeds of practical efficiency and stability may be obtained.

With Mr. Scott's suggestion that any objections which might be brought forward to the use of the induction motors would probably be urged on account of reasons applying to the supply system only, Mr. Dunn disagreed, because to design the system properly to eliminate these objections would cause the cost to go up out of all proportion to the result obtained. At this point Mr. Dunn exhibited a lantern slide of the curves shown herewith. The motors compared were three five-horse-power motors. One of them was a plain shunt motor adapted to 230 volts and 950 revolutions, the other was a constant-speed, compound-wound motor for the same voltage with a speed of 1,025 revolutions. The third motor was an induction motor of the same voltage, running at 1,130 revolutions at sixty cycles. The data for the induction motor were taken from the publications of a prominent company building such motors; the data for the direct-current motors were taken from tests made on commercial motors of standard rating taken out of the storehouse. In order that the results might be comparable the elements of the curves are all expressed in terms of percentage of full load. At full load the running current of the induction motor is about ten per cent greater than the running current of the direct-current motors; at full load the efficiency of the induction motor was about three per cent lower than that of the direct-current motors, and at overload rapidly fell off. The efficiency of the direct-current motors, however, was maintained. At full load the shunt motor falls off in its speed about four and one-half per cent; the induction motor about five to six per cent, and the compound motor about seven per cent. At 100 per cent overload the shunt motor is superior to either of the other types. When the induction motor is loaded to 2.6 times its normal torque it reaches its breakdown point, whereas both the direct-current shunt and compound machines keep turning, and the shunt motor does not "stall" until 640 per cent of normal torque is reached, while the compound motor continues until 1,080 per cent, or nearly eleven times normal torque, is reached.


COMPARATIVE PERFORMANCE
DIRECT CURRENT, AND INDUCTION MOTORS OF 5 HORSE POWER
SHUNT MOTOR 230 VOLTS SPEED 950
COMPOUND MOTOR 230 VOLTS SPEED 1025
INDUCITON MOTOR 2 PHASE, 200 VOLTS, 60 CYCLES SPEED 1130
SPEEDS
EFFICIENCIES
INDUCTION MOTOR EFF.
INDUCTION MOTOR SPEED
COMPOUND MOTOR SPEED
COMPOUND MOTOR EFF.
COMPOUND MOTOR CURRENT
SHUNT MOTOR CURRENT
SHUNT MOTOR SPEED
SHUNT MOTOR EFF.
CURRENTS
FULL LOAD
STARTING CURRENT INDUCTION MOTOR
STARTING TORQUE 220 %
STARTING TORQUE 640 %
STARTING TORQUE 1080 %
SPEED IN % OF FREE SPEED EFFICIENCY IN %
CURRENT IN % OF FULL LOAD RUNNING CURRENT
TORQUE IN % OF FULL LOAD TORQUES

COMPARATIVE PERFORMANCE OF INDUCTION AND DIRECT-CURRENT MOTORS.

With Mr. Scott's suggestion that any objections which might be brought forward to the use of the induction motors would probably be urged on account of reasons applying to the supply system only, Mr. Dunn disagreed, because to design the system properly to eliminate these objections would cause the cost to go up out of all proportion to the result obtained. At this point Mr. Dunn exhibited a lantern slide of the curves shown herewith. The motors compared were three five-horse-power motors. One of them was a plain shunt motor adapted to 230 volts and 950 revolutions, the other was a constant-speed, compound-wound motor for the same voltage with a speed of 1,025 revolutions. The third motor was an induction motor of the same voltage, running at 1,130 revolutions at sixty cycles. The data for the induction motor were taken from the publications of a prominent company building such motors; the data for the direct-current motors were taken from tests made on commercial motors of standard rating taken out of the storehouse. In order that the results might be comparable the elements of the curves are all expressed in terms of percentage of full load. At full load the running current of the induction motor is about ten per cent greater than the running current of the direct-current motors; at full load the efficiency of the induction motor was about three per cent lower than that of the direct-current motors, and at overload rapidly fell off. The efficiency of the direct-current motors, however, was maintained. At full load the shunt motor falls off in its speed about four and one-half per cent; the induction motor about five to six per cent, and the compound motor about seven per cent. At 100 per cent overload the shunt motor is superior to either of the other types. When the induction motor is loaded to 2.6 times its normal torque it reaches its breakdown point, whereas both the direct-current shunt and compound machines keep turning, and the shunt motor does not "stall" until 640 per cent of normal torque is reached, while the compound motor continues until 1,080 per cent, or nearly eleven times normal torque, is reached.

In work where there is liability to overload, as in rolling-mill work or ironwork of any kind, the liabilities of overload are very frequent and very severe. To get the same service out of an induction motor as from a direct-current motor a bigger

machine must be put in and the cost will be much greater. Mr. Dunn believed that, while the direct-current motor may require a little more attention, it is cheaper and can do more.

Mr. L. A. Ferguson continued the discussion. He also took up Mr. Scott's paper and stated that the experience of the Chicago company was that the operating expenses of substations is a mere bagatelle. He had found that where alternating-current arc lamps were put in direct substitution of direct-current lamps that the size of wiring had to be increased. As to the Nernst lamp, he thought that if the same amount of energy and brains was put on to the development of this lamp for direct-current work it would give us a better lamp and one that would be satisfactory. Mr. Ferguson did not think that alternating-current elevator motors were comparable now or would soon be comparable with direct-current motors. He found that customers were prone to put in hydraulic elevators instead of alternating-current machines. Mr. Ferguson also criticised Mr. Scott's reference to the use of storage batteries with alternating-current systems because he believed that the greatest advantage of the battery on direct-current systems is its instantaneous action, jumping into the breach as it were, when trouble comes along, without requiring any supervision.

Mr. Arthur Williams stated that the alternating arc lamp is not as efficient and useful in light-giving capacity as the direct-current lamp. As to the Nernst lamp, he thought that the best development, which was that made by German companies, had been along direct-current lines. Mr. Williams thought that automobiles would be a feature of central station work in the near future, and that the importance of elevator service could hardly be over estimated. In New York city, he said, there were 30,000 horse-power of electric elevators, representing a yearly income of not less than three-quarters of a million dollars to the electric companies. He did not like the alternating-current elevator motors in use.

President Steinmetz said that the supposed superiority of the continuous-current arc had been very severely challenged, and he believed rightly, in the last few years. He thought that whatever complication was introduced in an alternating-current system of distribution by the rotary converter was more than made up by the complication of the alternating system when used in its entirety, under which arrangement the complication was put at a point where it could not be controlled. Mr. Steinmetz said: "If a wireman has intelligence and capacity enough to learn the rules of alternating-current wiring he will not remain a wireman long, for he will soon aspire to a higher sphere."

Mr. Douglass Burnett did not think that any arrangement of hydraulic elevators using pumps driven by alternating-current motors could be used.

Mr. F. V. Henshaw pointed out that in some places the central station had practically all the business and in others every large building had an isolated plant. In order to supply large buildings and office buildings with current from the central station the elevator problem must necessarily be considered, and it forms an important part of the whole.

Mr. John W. Lieb, Jr., stated that the discussion had gone back to the old days of the conflict between alternating and direct-current believers, but that to those who would seriously and frankly examine the problem the conclusion would be that no definite pronouncement could be made one way or the other on this subject. The local conditions ought to be carefully studied in each case.

Mr. Charles F. Scott said that in considering the subject in a general way he felt that the burden of proof was put upon the direct current. The advocates of this variety of distribution had defended their cause and done it well.

He did not wish to take the position of a partisan but felt that he had to give the direct-current people a chance to show good reason for the faith that was in them. Referring to Mr. Dunn's diagrams, Mr. Scott said that at previous meetings of the Institute the enormous starting current of the induction motor had always been a point of attack, whereas Mr. Dunn's own curves showed that the starting current of his direct-current motors was something like twelve to eighteen times as great as their full load current. This, he thought, rather went beyond anything that had ever been said against the induction motor. Each type of motor, he continued, has its own characteristics and each has its own set of uses and special conditions which it can best fulfill. With regard to elevators, there are 300 alternating-current elevators in New York city, some of which have been running for several years, and these are run from the same circuits which are doing lighting work. Mr. Scott said that the best information he had was that the Nernst lamp is not at present satisfactory for direct-current circuits. He suggested further that if direct-current was so absolutely necessary for elevator service it might be made on the premises by generators driven by small induction motors, and this would save a good deal of trouble when compared with the system of changing over the whole current supply by means of rotary converters in order to meet this one small demand. He thought that it took an expert to lay out the kind of direct-current wiring in use in large buildings, and a man competent to do it could handle any kind of alternating current. Referring again to the ancient controversy, when the mention of alternating current was the red flag that would always cause any assembly of engineers to rise up and contend with one another, he said in his opinion it was a question whether the direct current would be permitted in future to retain even the little corner of the field that it now has.

Mr. W. S. Barstow said the matter of burden of proof depended somewhat upon which end of the subject you looked at first. He thought that the companies would have to generate the kind of current they could sell and give the customer what he wanted.

Mr. P. Torchio said that in the development of installation of factory work outside of large cities the 500-volt, three-wire system is perhaps better adapted than any other and that there was a tendency on the part of engineers nowadays to higher voltages.

It was announced that the subject for the next meeting, December 27, would be "Methods of Illumination."

Electrical Contractors.

A convention of the electrical contractors of the state of Pennsylvania will be held at Pittsburgh, beginning January 15, 1902. Mr. George R. Mathieu is president of the association.

Pan-American Buildings Sold.

The Chicago House-Wrecking Company has bought the buildings of the Pan-American Exposition for about $130,000. The contract for wrecking the buildings of the World's Fair, at Chicago, went to the same company. It is said that the demolition of the buildings will be begun at once.

Lehigh University.

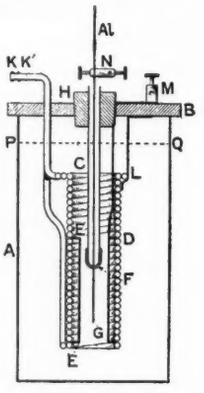
At Lehigh University a stone laboratory ninety by forty-three feet is being erected, to be used in connection with the steam engineering work of the course in mechanical engineering. Next fall a new and extended course in electrometallurgy will be offered at Lehigh University. Valuable gifts of surveying instruments, microscopes, etc., have been received recently by the departments of civil engineering and of geology.

Science Brevities

Radioactivity of Salts of Radium—A short abstract of a paper by MM. P. Curie and A. Debieme, which appeared recently in one of the Continental journals, has been published in the *Journal* of the Chemical Society. It appears that radioactivity may be communicated to distilled water by (1) distillation of a solution of radium chloride which has been allowed to stand several days; (2) placing a solution of a radium salt and distilled water in separate dishes in a perfectly closed space; (3) immersing in distilled water a celluloid capsule containing a solution of a radium salt. Such water may exhibit greater radioactivity than the substance from which it was prepared, but loses its power rapidly in an open vessel, and in the space of a few days if the vessel is kept closed. A solution of a radium salt also soon loses its activity in the open air, but regains it if transferred to a sealed tube. The author therefore considers that the radioactive energy may be transmitted by radiation, and also by a kind of conduction, whereby it passes from place to place by means of a gas or liquid, but not ordinarily through solids. A solution of a radium salt is hence in a state of equilibrium, and in a sealed tube, the loss of activity by radiation being slight, the value of the activity is high, but in an open vessel, the loss by conduction being considerable, the activity is very feeble.

Galvanic Coloring of Metals—A large number of recipes for the coloration and protection of metals are given in *L'Electrochemie* and abstracted in *Lightning*. Gilding on steel is imitated by galvanically coating with copper from a cyanide bath, then with a thin film of zinc. After drying and polishing, the article is heated in linseed oil to 160 degrees centigrade, when it is stated that the surface becomes of a red-brass color, as if there had been a real alloying of the copper and the zinc. Iron can be protected from rust by a layer of molybdenum, deposited from a bath containing one gramme of ammonium molybdate and fifteen to twenty grammes of ammonium nitrate per litre, with a current of two to five amperes per sq. decimetre. All varieties of iron can be covered with an adherent and unalterable deposit of peroxide of manganese by making them anodes in a bath containing about 0.05 per cent of manganous chloride or sulphate with five to twenty-five per cent of ammonium nitrate, the bath being cold, the cathodes of carbon, using a weak current of one to two amperes. Selenite of copper is recommended for coloring iron and steel brilliant black or blue-black, according to the strength; the layer, after firing is very permanent. The bath is made with selenious acid six to ten, copper sulphate ten, nitric acid four to six, to the litre of water. It can be also used for copper and brass with feeble currents. Mathey colors watch-hands and other small metal articles with gold or platinum, but not with silver, by placing them on an anode plate under about three cm. of solution, and dipping the cathode into the liquid over them until the required tint is produced.

Aluminum Rectifiers—M. W. Mitkiewicz believes that the electrode of an aluminum rectifier practically consists of a large number of Wehnelt interrupters mounted in parallel. The glow on such an electrode resolves itself under the microscope into an infinitude of minute luminous stars, making as many punctures of the thin film of aluminum oxide which covers the electrode. If the analogy holds good, it is not surprising that one phase of an alternating current is suppressed, since Wehnelt's interrupter does the same. Since, in an aluminum rectifier, the whole surface of the electrode does not take part in the transmission of the current, but only a portion of it, it is not necessary to employ large surfaces. The author uses an aluminum wire, cleaned by scraping with a knife. An account of M. Mitkiewicz's experiments has been published in the *Physikalische Zeitschrift* and abstracted in the London *Electrician*. The rectifier is shown in the diagram. It contains a solution of bicarbonate of soda. A is a five-quart glass vessel, B a lid of oak, carrying the leaden cooling worm D. EE is the second electrode, a leaden cylinder. H is a perforated stopper carrying the glass tube C, which contains the aluminum wire, and carries the rubber cap F. The author gives instructions how to rectify two-phase and three-phase currents with this apparatus.



ALUMINUM RECTIFIER.

Electrolysis of Molten Lead Iodide—Herr Gustav Auerbach recently published the results of some experiments conducted by him concerning the electrolysis of molten lead iodide and lead chloride, with particular reference to the application of Faraday's law and the theory of the electrolysis of molten salts. A short account of the experiments is given in the *Journal* of the Chemical Society, from which it seems that fused lead iodide at temperatures varying from 440 degrees to 800 degrees was electrolyzed by a current of twenty-four volts and one to two amperes. The amount of lead separated at the lowest temperature was only about ninety per cent of that which the current should form, and varied greatly in different experiments. As the temperature rises the yield becomes smaller. Faraday assumed that during the course of the electrolysis lead tetraiodide (PbI_4) was formed, but the author finds no evidence in favor of this view. In the electrolysis of lead chloride also the quantity of lead separated falls short of the possible amount. Determination of the quantity of chlorine formed proves conclusively that the carbon electrodes (and to a slight extent the undecomposed salt) absorb chlorine, and consequently the evolution of chlorine depends on the duration of the electrolysis. After the process has gone on for some time, and the carbon has become saturated, the quantity of chlorine liberated is nearly exactly (above ninety-nine per cent) equal to the amount required by Faraday's law. This is the first time that Faraday's law has been proved for the anode in the case of a molten salt. Lorenz (*Zeit. anorg. Chem.*, 1900, 23, 97) has suggested that the formula $a = 100 \cdot \epsilon/\epsilon'$ represents the yield of the current (a), where ϵ is the polarization of the molten salt, and ϵ' the depolarized value of the same. During the above experiments the polarization was also determined, and it has been found that Lorenz's formula, although not rigorously exact, gives approximate values. When the lead chloride is mixed with lead oxide, the yield is precisely the same as when fused lead chloride alone is used, but no chlorine or oxygen is evolved. During the electrolysis a metallic "cloud" is given off from the cathode, and spreads through the fused mass. As it comes near the anode it combines with the free chlorine there, and in this way gives rise to the irregularities in the amount of metal deposited, since the amount dissipated as "cloud" must vary greatly, with slight modifications of external circumstances. The "cloud" was examined by Tyndall's method, and it was proved that it is not formed of solid particles, but is a true solution of the metal in the fused salt, which fact is confirmed by the circumstance that metallic cadmium may be crystallized from its fused chloride.

THE ELECTRIC TRANSMISSION OF POWER FROM NIAGARA FALLS—IX.

(*Concluded.*)

BY LEWIS B. STILLWELL.

Experience also demonstrated that it was a mistake to place the three conductors constituting a circuit on the same horizontal plane and only eighteen inches apart. I may be excused for disclaiming responsibility for this arrangement in view of the fact that in 1894, acting as electrical engineer of the Westinghouse company, I submitted to the Cataract Construction Company elaborate plans and specifications for a transmission line in which the three conductors constituting a circuit were triangled, the sides of the equilateral triangle being thirty-six inches. These plans were rejected in favor of others and the arrangement actually adopted by the company proved very tempting to mischievous or malicious boys, who repeatedly short-circuited the line by throwing across it short pieces of wire which they succeeded in lodging across two or more of the conductors. The resulting short-circuit continued to blaze along the line until the power was cut off at the falls. The arc always traveled away from the power-house. This, I presume, was due to the fact that when the short-circuit occurred the conductors affected between the power-house and the point where the short-circuiting wire lay across the line repelled each other and very possibly, owing to the natural swing of the conductors, were brought more closely together than usual in that part of the span which lay beyond the short-circuiting wire. The arc caused by the short-circuit was one of great intensity, and at night the light was sometimes seen at distances exceeding half a mile. The conductors were afterward found to be considerably fused and in places little beads of copper projected from the strands. On one or two occasions, in trying to maintain service and in the hope that the arc would clear itself, power was kept on the lines for some twenty seconds, but on these occasions one or more of the conductors was completely severed. The trouble was finally cured by triangling the wires, bringing them into the position shown on one side of the pole in Fig. 17. You will note that in this method of triangling two of the conductors are carried on the upper cross-arm, while the third is carried on the lower cross-arm. This arrangement is preferable to the more usual plan of carrying two conductors on the lower and one on the upper cross-arm, since it is much more difficult for a mischief-maker to lodge a wire or stick in contact with two conductors.

The first pole line originally extended to a small terminal-house located on the banks of the canal, near Albany street, in Buffalo, a point about two miles inside the city limits. In this terminal-house the overhead circuits were connected to the cables used to convey currents to the various substations in Buffalo, the apparatus in the terminal-house comprising only lightning arresters and single-blade switches for changing connections of overhead and underground lines. These switches were not designed to open the circuits when power was being delivered, but were intended simply to facilitate changes in case of accidents causing interruptions of the service.

In the year 1900 a new terminal-house about two miles farther down the river than the old one was erected, and the construction of a second pole line from Niagara was undertaken. The cable system in Buffalo was extended to the new terminal-house, and the first two power circuits, designated, respectively, No. 1 and No. 2, which were carried upon the old pole line, were connected to the underground system at this point. It was decided to increase the potential on the overhead transmission lines from 11,000 to 22,000 volts, and as it was deemed impracticable to use 22,000 volts in the underground cables and at the same time seemed desirable to secure electrical separation of the overhead and underground circuits, step-down transformers having a ratio of 22,000 to 11,000 volts were installed in the terminal-house. Switching devices providing for connection and disconnection of the overhead transmission circuits and of the underground cable circuits, together with an elaborate outfit of apparatus intended to protect the transformers against the effects of lightning, were installed.

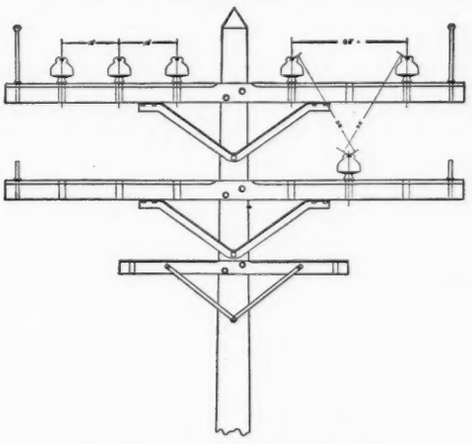


FIG. 17.—ARRANGEMENT OF WIRES.

The new pole line differs radically from the old one. From Niagara to Tonawanda the length of span is doubled—that is to say, the average span in the new line is about 140 feet as against an average of seventy feet in the old line, these averages in both cases applying to tangents and not to the curved portions of the respective lines. The poles are similar to those used in line No. 1, but every third pole is substantially guyed. The unusually close spacing of poles in the old line is explained by the fact that it was assumed that during sleet storms ice might cover the conductors to a radial depth of half an inch, which, if it did actually occur, would of course greatly increase the pressure, tending to overthrow the line during wind storms, which upon the Niagara frontier are often very severe, but experience during a number of winters has demonstrated the fact that ice never adheres to the power circuits while they are traversed by the working currents. This result is due in part presumably to the heating effect of the current and in part perhaps to static repulsion. It is certain that dry snow is statically repelled by the charged conductors, and I think it probable that this effect also helps in the case of sleety rain. In the case of the new line, calculations of the effect of wind pressure were based upon the projected area of poles, cross-arms and conductors, but with no allowance for a covering of ice. Experience has shown that mechanically the weak point in the construction of the old line was the junction of pin and insulator and for the new line a new pin and new insulator were specially designed. Cross-sections of the old and new types are shown in Fig. 16. The old pin at the top is but seven-eighths inch in diameter, while the new one is one and one-half inches. On the old pin but six threads engage with the threads in the pinhole of the insulator, while in the new one nine threads are used. It is a singular fact that almost every power circuit hitherto erected in the United States has used an insulator pin of the same diameter at the top as the standard Western Union pin which was designed for a very different kind of service. Without going further into details, it is sufficient to say that notwithstanding the fact that the length of span is doubled, the insulators of the new line are relatively much more securely fixed upon their pins than are those of the old line.

Tests were made to determine the horizontal strain which would break pin or insulator or both if exerted at the top of the insulator; *i. e.*, at the point where the pin rests upon the insulator. It was found that a pin will break at the point where it enters the cross-arm under a pressure of about 2,100 pounds, which is about six times the calculated maximum pressure to which it will be subjected in service. The shoulder of the insulator will break under a horizontal strain of about 1,300 pounds in service. The maximum strain upon the shoulder due to wind pressure against the conductor is probably never exerted at an angle of more than forty-five degrees from the vertical, and against a pressure in this direction the strength of the insulator saddle is much greater than against a horizontal pressure such as that used in the test. The insulators, as regards quality of the porcelain, show a very marked improvement as compared with the best that could be obtained in this country a few years ago. Before being placed in position, each insulator was tested in a manner similar to that which I have described for the insulators used on the old line, except that the new insulators, which have been designated type E, were subjected to 60,000 volts, alternating. Under this very high potential, only about three per cent of those furnished by the manufacturer proved to be defective. Of the last lot of over 400 not one failed under the test.

Aluminum conductors are used for the new line. The old and new pole lines follow the same route from the power-house to a point a short distance beyond Tonawanda where they diverge, the new line, from the point named to the terminal-house, which is located just inside the city line at Buffalo, being approximately three miles shorter than the old lines. Taking into account the difference of the length of the line and in specific conductivity of copper and aluminum, the equivalent section of conductor for the new line works out about 497,000 c.m. The manufacturer guaranteed the conductivity of the aluminum conductor to be not less than sixty-one per cent by Matthiessen's standard. The impedance of each circuit was calculated, and a section of 500,000 c.m. adopted for the aluminum conductor, which is, of course, a stranded cable. The line has been in use since April 1, 1901, and when operating in parallel with one of the old lines, the load is so equally divided that no difference can be detected by readings of the indicating wattmeters used. Where the aluminum conductor passes through that part of the company's territory where large chemical industries are established, it is protected by a braided cover treated with asphaltum. The principal reason for choosing aluminum instead of copper was its less cost, the aluminum line at the time when it was ordered costing about twelve per cent less than an equivalent copper line.

In commercial use the line thus far has been eminently successful, not a single instance of an insulator breaking down in service having occurred.

The guaranteed maximum resistance of the conductor is 0.03472 per thousand feet and the minimum tensile strength is 23,000 pounds per square inch, with average tensile strength of 25,000 pounds per square inch. By calculation, with temperature of wire twenty degrees Fahrenheit below zero, the maximum strain upon the wire will be slightly more than one-half the minimum tensile strength. In erecting the line, the sag was adjusted with reference to temperature of the air at the time of erection in accordance with a table based upon data set forth in the valuable paper upon "The Use of Aluminum Line Wire and Some Constants for Transmission Lines," by F. A. C. Perrine and F. G. Baum, read before this Institute May 18, 1900.

The joints are spliced and wrapped, but are not soldered. An interesting difference in the behavior of the old and new lines when the wind is blowing at high velocity has been observed. At such times, the tightly strung copper conductors of the old line swing or vibrate irregularly, but, on the whole, rapidly, and the strain caused by this vibration is transmitted to the insulators, pins, cross-arms and poles in such a manner that the trembling of the pole may be detected by placing the hand against it at a point near the ground. Under similar circumstances, the aluminum conductors tend to assume a fixed position, which is sometimes apparently as much as forty-five degrees from the vertical plane in which they hang when the air is quiet. There is practically no vibration perceptible at the pole. The elimination of vibrating strains upon insulator and pin is gratifying, as in the old line the tendency of insulators to work loose from their pins has been noticeable, and I have no doubt that it has been caused by the vibration of the conductors during heavy wind storms.

Present Output of the Plant—In Fig. 18 the load curve for local service and for long-distance service, as compiled from half-hourly wattmeter readings for the twenty-four hours ending at midnight, July 20, 1901, is shown. The local load varies between 14,200 kilowatts and 15,700 kilowatts. This remarkable uniformity of output is explained by the fact that nearly all of the power used locally is delivered to manufacturing companies whose processes are continuous and whose use of power is practically constant. The long-distance load varies from a minimum of 3,300 to a maximum of 15,600 kilowatts. Of this maximum, probably ninety per cent is used for railway and lighting purposes.

XI—THE ELECTRIC EQUIPMENT OF THE TERMINAL-HOUSE.

Power from Niagara is delivered to the terminal-house at present by three overhead circuits, each of which is calculated to deliver the output of two alternators at the Falls, less the losses in step-up transformers and in the transmitting conductors. Two of the transmitting circuits are therefore ample for the present use of power in Buffalo, which does not exceed 14,000 kilowatts, except for about two hours in the evening, when it rises to nearly 16,000 kilowatts. The loss in step-up transformers is slightly less than two per cent, and the loss in the transmitting circuits, when two of them are used to deliver the combined output of four alternators working under full rated load, is about six per cent. If four alternators at Niagara deliver to the step-up transformers their full rated output—*viz.*, 14,920 kilowatts—any two of the transmitting circuits operated in parallel will deliver to the step-down transformers at the terminal-house about 13,750 kilowatts. Of this amount the step-down transformers will deliver to cables which convey power to the various substations in Buffalo not less than 13,500 kilowatts. The net calculated efficiency of the transmission, including losses in step-up transformers, transmitting circuits and step-down transformers, when two circuits are in use under rated load, is, therefore, a little above ninety per cent. About three weeks ago I had the pleasure of calling the attention of the president of the Cataract Construction Company to a copy of a letter addressed to him, under date of January 7, 1893, in which, in reply to an enquiry, I had made a statement of the efficiency that could be guaranteed for transmission from Niagara to Buffalo, and of showing him, at the same time, a letter from Mr. Philip P. Barton, superintendent of the Niagara Falls Power Company, dated July 15, 1901, giving comparative wattmeter readings at Niagara and Buffalo during June of the present year. The efficiency prom-

ised in 1893 under conditions of line loss equivalent to those which actually obtained in operation during June last was eighty-eight per cent. Mr. Barton's letter states: "We have been receiving daily readings of the meters at the terminal-house since June 1. I am therefore able to give you a comparison of the total kilowatt-hours delivered from our bus-bars with the kilowatts delivered from the secondaries of the step-down transformers at the distant terminals of the line for the month of June. This is taken from actual meter readings, except for the case of our Lockport tenants, in whose plants no integrating watt-meters are installed. The number of kilowatt-hours received by these tenants has been carefully estimated from our knowledge of their average loads. The total number of kilowatt-hours delivered from our bus-bars to our long-distance transmission circuits, as shown by our feeder meters for the month of June, is 6,504,000. The total number of kilowatt-hours delivered from the secondary transformers in the terminal-house, in the Tonawanda substation and in the plants of our Lockport tenants, as shown by actual meter readings in every case, excepting those of the Lockport tenants, is 5,840,100, thus showing a net transmission efficiency of 88.4 per cent." During the month of June the transmitted load was carried sometimes on one circuit and sometimes upon two circuits. I have calculated the losses in the lines and find that they averaged 6.5 per cent. Of course, commercial meters can not be depended upon for closely accurate reading, but in this case the readings at Niagara were made by ten meters and at the distant terminals of the line by twelve meters. It may therefore be assumed that errors are averaged, and that the result is probably accurate within one per cent. By calculation, with 6.5 per cent line loss, the net efficiency of step-up transformers, line and step-down transformers should be 89.5 per cent. Calculated results now show higher efficiency than those made in 1893, simply because the actual efficiency of the transformers is higher than that assumed at the time named. The very close agreement of calculated and measured efficiency will not be surprising to members of this Institute, but may be useful in answering the question often asked: Whether results based upon electrical calculations are realized in practice.

The power, which is delivered by overhead lines to the terminal-house of 22,000 volts, is reduced in potential and delivered to underground cables at 11,000 volts by two groups of transformers connected in delta. The rated output of each transformer is 2,250 kilowatts and three transformers are therefore capable of transforming the full amount of energy which two alternators and eight step-up transformers at the Falls and one transmission circuit can deliver to the terminal-house. In operation, all of the alternators used to supply Buffalo service are operated in parallel, as are also the transmission circuits used and the two groups of step-down transformers, but in planning the general features of the terminal-house installation the possibility of ultimately operating two or three more electrically separated sets of alternators, lines and transformers was kept in mind and the transformer unit was therefore so selected that a group of three corresponds in output to one transmission circuit. In approximate figures 7,500 kilowatts (10,000 horse-power) delivered in Buffalo call for two alternators, eight step-up transformers, one transmission circuit and three step-down transformers.

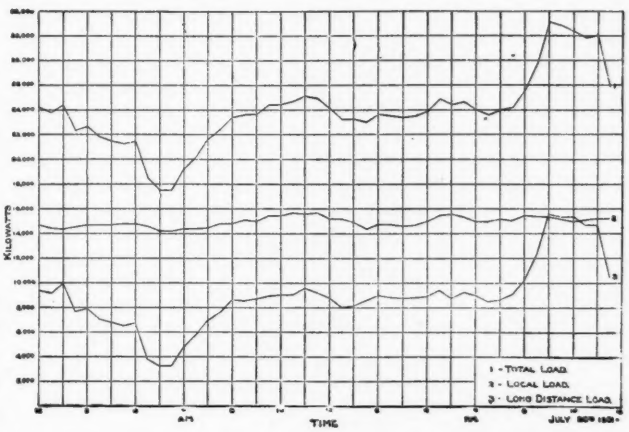


FIG. 18.—LOAD CURVES FOR LOCAL AND LONG-DISTANCE SERVICE.

To light a city of nearly 500,000 inhabitants, to supply power for the entire street railway service of that city, to deliver an aggregate of many thousands of horse-power used for a very great variety of purposes and at points scattered throughout a territory some eight miles long and four miles wide, to do all this by a system of underground cables which in turn receive their supply through overhead lines exposed to lightning, to the winter storms of the Niagara frontier and to wanton interference of mischief-makers, and under these circumstances to secure a delivery of power free from all interruptions and in every way satisfactory to the users, is by no means an easy task. The theorist may say, get rid of your overhead lines and construct a tunnel or subway, but this, as I have pointed out, is a commercial, if not an engineering, impossibility, owing to its great cost, at least until the aggregate use of power in Buffalo becomes so large that the cost of the underground construction will no longer add to the cost of power at Niagara an amount so great as to render its cost in Buffalo commercially prohibitive. The practical man may say, "You are attempting an impossibility; it is not reasonable to expect that you can tie to one central source by electrical connections, sensitive as human nerves, every industry that employs power in western New York, expose these electric nerves through half their length to lightning and storm, expose them again in half a dozen substations in complicated switch gear to the manipulation of a large number of attendants and then expect to get along without frequent attacks of temporary paralysis." But if such a view be accepted, progress is impossible. It must be frankly admitted that up to the present time the results of efforts put forth to make the service absolutely continuous and reliable have not been entirely satisfactorily, but the creation of a system that shall in a perfectly satisfactory manner distribute throughout a territory so extensive and so complex in its requirements the surplus power of the Falls is necessarily an evolution requiring time. Very substantial progress has been made; apparently very many difficulties remain to be surmounted.

The equipment of the terminal-house by the Cataract Power and Conduit Company will make it possible to introduce improvements in the system of distribution in Buffalo which may be reasonably expected to eliminate certain causes of trouble.

The system of distribution in Buffalo has been recently described in a very able paper read before the Institute by Mr. H. G. Stott, and I shall not attempt to describe it here. With the terminal-house equipped, the supply of power to substations in Buffalo presents to the Cataract Power and Conduit Company exactly the same problems that would have to be met were a central power-house using steam-driven alternators substituted for the terminal-house except that on the Niagara side of the 10,000-volt bus-bar step-down transformers, transmission circuits and

the power plant at Niagara take the place of the alternators and steam plant.

The local system of distribution at Niagara is probably as perfect as any in existence and there is every reason to expect that when the extensions and alterations in the cable system and in switch gear at substations, which are now made possible by the installation of the terminal-house equipment, are completed the distribution of power in Buffalo will be thoroughly satisfactory to all concerned.

At the terminal-house, the protection of step-down transformers against the effects of lightning is extremely important and not altogether easy to accomplish. The apparatus installed for the purpose comprises lightning arresters, reactance coils and a new device which the Westinghouse company put upon the market and designated by the name "static interrupter." The lightning arresters proper comprise spark-gaps between Wurts non-arcing metal cylinders in conjunction with the usual ground wires and plates, but the arrangement of the spark-gaps differs materially from that generally used hitherto, a non-inductive resistance being used in series with all of the gaps while a part of the gaps are shunted by a non-inductive resistance. This apparatus, which has been designated the "low-equivalent lightning arrester," has been fully described in a circular issued by the company referred to.

It seems reasonable to expect that the separation of overhead and underground lines by interposition of step-down transformers in the terminal-house will obviate some of the difficulties which have hitherto resulted probably from the metallic connection of overhead and underground circuits. That the lightning arrester equipments at Niagara and at the terminal-house are effective is evidenced by the fact that no transformer at either point has ever been damaged by lightning, although on several occasions the line has been struck so heavily that cross-arms and even poles have been shattered.

XII—THE EQUIPMENT OF POWER-HOUSE NO. 2.

I do not propose to discuss in detail in this paper the electrical equipment now in course of construction in power-house No. 2. Shortly after preparing the general specifications for that equipment, I resigned my position as electrical director of the Niagara Falls Power Company to give attention to other enterprises. The company has been fortunate in securing the services of Mr. H. W. Buck as electrical engineer in charge of new electrical construction, and it is to be hoped that when the new plant is installed he will describe in detail for the benefit of the Institute the modifications introduced as a result of experience and the results realized therefrom. Meanwhile, however, without impropriety and without trenching upon the province of those upon whom will rest the responsibility of carrying out the plans thus far determined and extending them to meet the requirements of future growth, I may outline briefly the more important features with respect to which the equipment of power-house No. 2 will differ from that of power-house No. 1.

The general organization of the equipment will differ in having all switch gear and measuring instruments located in one structure instead of in two separate structures. The ultimate equipment will comprise eleven 3,730-kilowatt alternators, wound for two-phase and 2,200 volts. Oil switches operated by electric motors in combination with spring mechanism will be used. The cable subway, which, in power-house No. 2 as in power-house No. 1 is parallel to the row of alternators, will be widened to an extent sufficient to permit installation of all bus-bars and connections except the vertical risers to the switches below the floor line of the power-house. Above the floor line and directly over the subway which is opposite the middle of the row of eleven alternators the switches will be placed in brick compartments, faced on the outside with white enameled brick. As in power-house No. 1 two sets of bus-bars will be used. The circuit from alternators to bus-bars passes first through a circuit-breaking switch with time-limit overload attachment and thence to terminals of a pair of oil circuit-breaking switches, non-automatic, by means of which connection is made to either or both sets of bus-bars. Pairs of switches similarly arranged are used for each feeder circuit, but these are automatic with time overload attachment. All switches are of the new type developed by the General Electric Company, in which the circuit is broken under oil, the four sets of terminals of each switch being enclosed in separate brick compartments.

Instead of instrument stands, a switchboard of blue Vermont marble, located upon an elevated platform about the middle of the power-house, will be used to mount the indicating and measuring instruments. Below these instruments, and extending the entire length of the board, a distance of seventy feet, the small switches which electrically control the movements of the large switches in the alternating-current circuits will be located and these will be assembled in connection with an organization of dummy bus-bars and connections in such a way as to constitute an exact diagrammatic representation of the actual existing connections of the power circuits. While the organization of switchboard apparatus in power-house No. 1 is remarkably free from complication, experience in the operation of the plant has demonstrated the fact that in time of emergency the most skillful operator is liable to make mistakes. When something goes wrong, the operator has no time to draw diagrams nor even to think diagrams. At such times the eye is a quicker and more certain guide than the mind. I feel confident that the use of the diagram switchboard arrangement will materially contribute to the safety and certainty of operation.

The regulation of the alternators will be materially closer than that of the machines thus far installed, my specifications calling for an armature current three times normal full load current when armature is short-circuited under conditions of full load field charge, while in the old machines the armature current under such conditions was about twice normal full load current.

The external appearance of the alternators will be considerably changed by the removal of the bridges, this being made possible by locating the field collector rings on the shaft below the stationary armature and carrying the exciting current to the fields by wires placed inside the hollow shaft.

In other respects, the new alternators will not differ materially from the old ones.

As in the case of power-house No. 1, exciting current will be supplied by continuous-current machines driven by turbines, but in the case of power-house No. 2 these will be located in chambers excavated in the sides of the wheel pit at the level of the turbine deck. Experience has shown that similar chambers in the old wheel pit are almost perfectly dry and it is thought that the simplification of the hydraulic plant required to drive the exciters, which results from placing them nearer the bottom of the wheel plant, will reduce chances of possible interruption of service by reason of trouble with the exciter, turbines and shafts.

I began this paper by saying that "The history of the Niagara Falls power plant is a demonstration of the ability of applied electrical engineering science to attain in commercial practice results predicated in large degree upon theory." What are the practical results thus far attained?

Briefly, the Niagara plant has contributed in no small degree to the development of a considerable number of important chemical industries, and is already the centre of a prosperous and rapidly growing manufacturing community. It is lighting Buffalo, Tonawanda, Lockport, and Niagara Falls, and is operating the electric railway systems in the cities and towns named.

For the first six months of the current year, the output of the plant was 104,378,000 kilowatt-hours. A steam-driven plant, delivering the same output and using three pounds of coal per unit at the switchboard, would have burned in the time named 156,000 net tons of coal—more than 800 tons per diem.

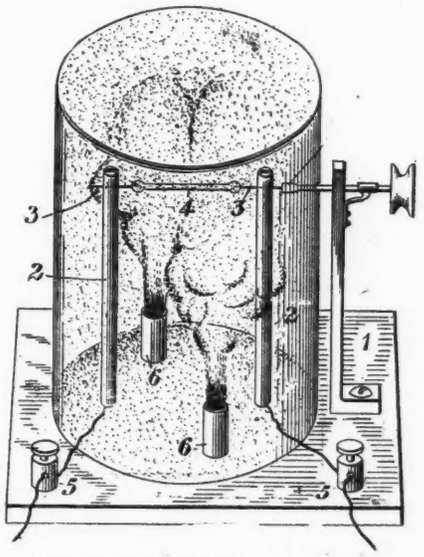
The generating plant, including alter-

nators, exciters and switch gears, has been remarkably successful and satisfactory in operation. The cost of maintenance and repairs for the past two years has been less than one per cent, while maintenance and repair of the motive power plant, including turbines, governors, pen-stock, shafts, inlet racks, etc., has approximated two per cent. The local distributing system also has proved satisfactory in service. The long-distance transmission and distribution of power hitherto has been subjected to occasional interruptions, brief in duration but nevertheless seriously annoying. The separation of overnead and underground circuits effected by the use of step-down transformers in the terminal-house, improvements in organization of the local distributing system in Buffalo now rendered possible by the installation of the terminal-house equipment and the gradual elimination of weak points in the system justify the belief that the interruptions of the long-distance service will become less frequent than in the immediate past, but until the time arrives when it shall be commercially feasible to use cables instead of overhead lines occasional interruptions of service are apparently inevitable.

I can not close this paper without referring to the excellent work of the operating department of the Power company. It is not difficult to plan upon paper an extensive system of interconnected and mutually dependent electrical apparatus which will work perfectly—on paper—but such an organization of apparatus realized in iron and steel and copper requires for its successful operation the utmost degree of systematic vigilance upon the part of a thoroughly organized and disciplined force of trained operatives who must be not only familiar with their routine duties but ready to act with promptness and certainty in time of emergency. The professor who sits in his study, examining diagrammatic connections of an extensive electrical system, is usually able to work out a solution of any difficulties which he may imagine—he can see just what switches should be thrown and what new combinations should be made; if he makes a mistake in his first solution no damage has been done, and he may try again. But the operator on the switchboard controlling 50,000 horse-power must do his work under conditions very different from those of the study, and he can afford to make no mistakes. It is high praise for the organization and personnel of the operating force at Niagara to say of the various troubles that have occurred in operation those due to mistakes or to lack of vigilance constitute a proportion quite insignificant. This result has been largely due to the foresight and systematic methods and organizing ability of the superintendent, Mr. Philip P. Barton, and to the prompt resourcefulness, technical skill and extraordinary coolness in emergency of the resident electrician, P. M. Lincoln. It is a pleasure to be able to thus publicly express my appreciation of the able assistance of these gentlemen during the years in which we have been associated in the work at Niagara.

Electrical Patents

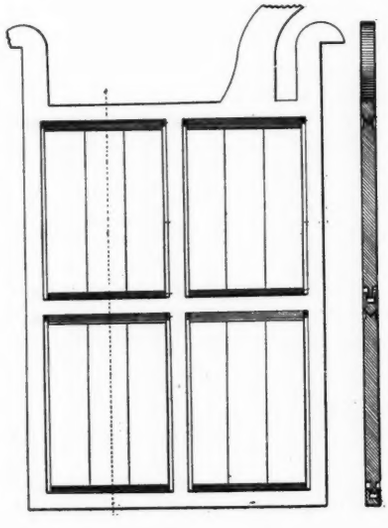
Improvements in glower or Nernst lamps are continually being made in rapid succession, and all are immediately patented, Mr. George Westinghouse, of Pittsburgh, Pa., being the purchaser of these patents, and thus completely controlling the manufacture of the lamps. Among the many recent improvements are two which seem to be especially important, one being devised by Mr. Marshall W. Hanks, of Pittsburgh, Pa., and the other by Herr Walther Nernst, of Gottingen, Germany, the original inventor of the lamp. The object of Mr. Hanks's invention is to provide a glower that is adapted to circuits of a given voltage. The adaptability of



METHOD OF TREATING LAMP GLOWERS.

glowers to any given voltage is determined by one or by all of three factors—to wit, length, cross-section and composition—and it has generally been the practice to make the glowers for use with circuits of any given voltage as nearly as possible of the same composition, the same diameter and the same length; but however much care may be exercised in the manufacture more or less variation from the condition desired is likely to be found when the glowers are actually placed in service. After the glowers have been completed it is obviously not feasible to change the composition or to decrease either the diameter or the length. The inventor therefore proposes to provide glowers which actually require higher voltages than that for which they were originally intended, with coatings of material, the composition of which is the same as or similar to that of the material of which the glower body is formed. His invention, therefore, relates to a method for applying this coating, and in order to have it uniform on all sides the glower is mounted so that it may rotate. At the same time it is maintained at an elevated temperature, while the coating is applied. By referring to the illustration herewith presented, the operation will be readily apparent. The inventor aims to subject the glower while in a heated condition to a cloud of powdered material, the composition of which is the same as or similar to that of the body. Therefore, if the glower is treated while hot and is rotated during treatment, the powder will be deposited thereon in a substantially uniform layer, the treatment being continued until a voltmeter connected across the circuit, which is supplying the energy for heating the glower, indicates that the desired increase in cross-section has been attained. He therefore provides a base 1 with vertical posts or standards 2 of suitable conducting material which shall have supporting bearings for the terminal wires 3 of a glower 4. The current for heating the glower may be transmitted from suitable binding-posts 5, to which are connected conductors 5 *a*, leading to a source of energy having the desired electro-motive force. Any suitable heating means may be obviously employed for raising the temperature of the glower to a conducting temperature. The powdered material to be deposited upon the glower is blown through tubes 6, projecting through the base 1, by means of any suitable blowing device. In order to confine the powdered material within suitable limits, the standards 2, the glower supported thereby, and the tubes 6 are enclosed within a suitable casing 7. In case it is desired to rotate the glower during treatment, a shaft 8, provided with a suitable clamping device 9 at one end with a pulley 10 at the other, may be mounted in a bearing bracket 11, supported on the base 1. The end of the shaft having the clamping device 9 may project through a suitable opening in the side of the casing 7, so as to receive the adjacent terminal wire 3 of the glower. By applying a suitably driven belt to the pulley 10 the desired rotation of the glower may be effected. After the glower has been treated in the manner set forth it may be removed and another substituted therefor and subjected to the same treatment. The casing 7 is provided with a removable cover in order that the glowers may be inserted and removed without disturbing the body of the casing. Dr. Nernst's invention relates to the ingredients employed in the glowers, and the following is an extract taken from his specification: "The chief requirement

for glowers formed from materials which are non-conductors when cold, but which become conductors when heated, are that they shall operate for a considerable period with but little change in the voltage required to cause a given current to pass through them, that they shall vary as little as possible in the amount of light which they emit during their period of operation, and that they shall have mechanical strength sufficient to withstand ordinary use. I have experimented with a very great number of those substances which increase in conductivity as they become heated, and I have subjected them to a great variety of tests and have used them for actual lighting purposes during many hours of service. I have constructed certain glowers by taking oxide of zirconium, about eighty parts, and mixing it with about twenty parts of all the rare earths which are found in gadolinite. In general gadolinite may be described as a black, vitreous subtranslucent silicate having the approximate formula $Fe, Y_2, Be_2Si_2, O_{10}$ and it is closely analogous to several other minerals, notably, euxinite, allanite and orthite. It is known that this mineral contains a number of the rare earths, and I have sometimes treated this mineral and separated out from it the individual rare earths to be used as elements of electric lamp glowers or for other purposes; but I find that if I combine about twenty parts of the composite mixture of rare earths which are found in gadolinite with about eighty parts of the oxide of zirconium I am able to produce a glower which has most or all of the qualities desired. My present invention relates to the improvement in glowers, which consists in using as the material for such glowers about eighty parts of the oxide of zirconium and about twenty parts of a mixture of all the rare earths found in gadolinite. I find it of advantage in some cases to separate the rare earths of gadolinite into two divisions, the one containing the earths of the cerium group, the other those of the yttrium group, and to use in making glowers only those of the yttrium group which I term the 'yttrium earths.' The cerium group comprises cerium, didymium, samarium and some others of hypothetical existence, while the yttrium group is generally considered to include yttrium, erbium, terbium, ytterbium, scandium and such metals as thulium, holmium, dysprosium, gadolinium and decipium are by some chemists ascribed to that group. While the metals of the cerium group are not necessarily injurious, their presence would usually seem to be unnecessary and sometimes troublesome, owing to their being, as a rule, volatile at somewhat lower temperatures than the oxides of the metals of the yttrium group. The manner in which I make a glower having the constituent elements above set forth is to take about eighty parts of the oxide of zirconium and about twenty parts of the rare earths of gadolinite or of the yttrium group therein, both in a powdered state, and form from them a paste by adding water and some binding material, such as tragacanth, dextrine or the like. The powdered oxides are first fully mixed together, and the binding material is also finely powdered and thoroughly mixed with the oxides. Sufficient water is added to form a paste, and the glowers are then shaped by any preferred process. In case the glowers are to be tubular in form, the pasty material is passed through a press and shaped by that means. The rods or strips of material thus shaped are dried and baked thoroughly in any suitable manner, and conducting terminals are secured to the ends of the glowers in any convenient way."



STORAGE BATTERY PLATE HOLDER.

Mr. Charles S. Kaufman, of Chicago, Ill., has recently obtained a patent on a plate-holder for electric storage batteries, and has assigned the same to the American Battery Company, of Chicago, Ill. In electric storage batteries it is desirable to employ a plate-holder which shall hold the plate firmly in place and at the same time allow for the growth or expansion of the plate, which occurs in continued use, especially when subjected to strains in charging and discharging at comparatively high rates of current covering a considerable period of time, in which case the plate expands very materially, and with the plate securely fastened at all points such growth or expansion would cause the plate to bulge or buckle, thus producing a short-circuit by contact with adjacent plates. In order to accommodate a number of plates, the plate-holder or frame is provided with a plurality of openings, each of which is adapted to receive a plate, so that a number of plates may be used in the same holder. These openings are secured by dividing the holder into sections with partitions, making the openings of any desired size. The upper sides of the plate openings are provided with beveled edges, to which the plates are securely attached by welding or brazing or in other desired ways for the purpose of holding them firmly and securely in place. The lower sides are provided with grooves into which the lower ends of the plates are loosely received for the purpose of permitting the plates to expand in a downward direction, as such expansion occurs in use. The plate openings are constructed of a size sufficient to allow a space at the sides of the plates for the purpose of permitting them to freely expand sidewise without hindrance. The lower ends of the plates are preferably provided with a tongue, fitted loosely into the slot in the lower sides of the plate openings. By this arrangement the plates can be securely fastened to the plate-holder, rigidly at one part and loosely at the others, so as to prevent them from being loosened or shaken out, while at the same time furnishing ample space for the growth or expansion which takes place during protracted use.

A New Steamship.

On the occasion of the third trip to this country of the steamship La Savoie, of the Compagnie Generale Transatlantique, a number of invitations were issued to visit the ship. This steamship is an example of nearly all that is modern and good in commercial marine architecture. She is not designed to make remarkably high speed, but throughout the intention has been to provide every means of comfort to those who have occasion to travel on her.

Several features of her equipment are of interest electrically. She is provided with wireless telegraphy apparatus and on her last voyage messages were exchanged with the station at Nantucket from a point forty miles distant. All the cabins are provided with a complete telephone system, thus rendering it more convenient for any one who desires anything to call for it.

CONSTRUCTION OF SMALL TELEPHONE EXCHANGES—XVI.

BY A. E. DOBBS.

HOUSE WIRING.

House wiring should be neatly done and the wires as nearly as possible concealed from sight; it can not be too well done. Staples and tacks should be used sparingly, or, better still, not at all, as they always make a weak spot in the insulation.

If the house should be a frame one it is comparatively easy to dead-end the wires quite a distance above the ground at a point directly above the telephone, drop down between the weather-boarding and the plastering and, by "fishing," pick up this wire directly over the instrument, using rubber insulated and braided wire for this purpose. This wire, under these circumstances, need not be tightly drawn; on the contrary it should be quite slack, as inside the walls it can do no harm and is not seen; neither does it require the use of staples, and, if necessary, it can be pulled out and renewed at any time.

BURGLARS *vs.* THE TELEPHONE.

One good reason for keeping the outside wires as high as possible is to keep them out of the reach of mischievously inclined persons as well as of burglars, for these last-named gentry will cut the wires before entering a house if it is possible for them to get at them, and after some of their recent exploits in which their designs were foiled by the use of the telephone they will be more apt to try to sever telephone connections than before. It would be well to instruct your customers that, in case of burglary, they should always try to call the office, first placing a finger on the clapper of the bells to keep them from ringing, ring "Central," speak in a whisper directly into the transmitter, and instruct the operator to notify the police or the nearest neighbors. These instructions should not be advertised broadcast but should be imparted directly to the parties concerned, either verbally or by private circular.

One manager in an Ohio town recently received a large access to his subscription list, owing to the fact that a burglary was frustrated, a lone woman probably saved from maltreatment and one of the would-be burglars shot dead because the lady of the house was able by an intelligent use of the telephone to call the operator, who, in turn, notified the police and her nearest neighbors so that by the time the burglars got fairly into the house it was surrounded on all sides.

Therefore the possibility of wire-cutting should always be considered when making house connections and work of that kind rendered as difficult as possible. Of course, if the burglars are expert enough

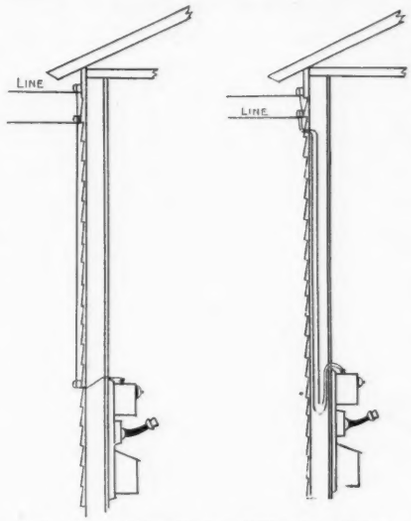


FIG. 65.—METHODS OF ENTERING FRAME BUILDINGS.

to climb poles and trace wires accurately they can cut them anyhow, but for all that it is hard to find a wire in the dark and climbing a pole after nightfall is apt to attract attention.

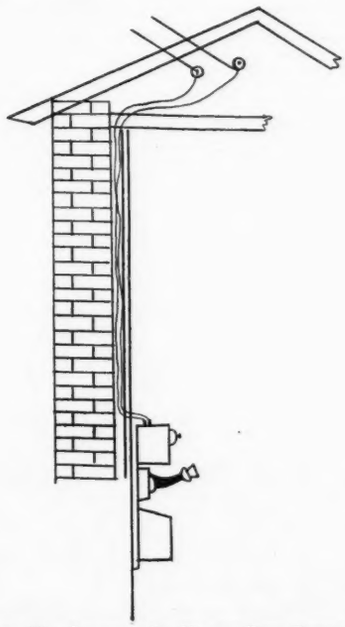


FIG. 66.—LEADING IN WIRES RUN BEHIND PLASTERING.

TO RETURN TO OUR SUBJECT.

One great help toward getting wires around a room is the ordinary picture moulding, on the top of which wires can be concealed when it becomes necessary to enter a room at one side and reach the instrument at the other. In this case a thin wire nail should be driven over the moulding and directly into the wall to hold the wires down, and a hole bored into the plaster will allow them to be dropped down to a point just above the telephone and fished out again. In a great many cases they can be brought into an attic, dropped down between the walls into the cellar and carried to a spot directly underneath the telephone (Fig. 67), which can be found by boring through the floor with a small bit and afterward fishing the wire up to the instrument in the same way. After boring this test hole through the floor just spoken of, the middle of the wall can be estimated, which will generally be from two to four inches further over. In all cases bring the wires inside of the baseboard and never bring them through the floor outside of the baseboard if it is possible to avoid doing so.

To reach the telephone, bore a hole in the plastering just above it, attach a small weight, as a heavy nail or piece of strip solder, to the end of a string, drop it down until you can feel the weight strike the floor, and fish it down from below with a piece of bent wire with a hook on the end. A little practice will enable one to become quite expert at this kind of fishing and make the running of concealed wires almost as expeditious as though stapled around the room, while the work is a great deal neater.

Sometimes a cold air ventilating pipe can be used to push a wire through, but in some instances of this kind the wiremen have failed to notice the difference between cold air and hot air pipes and did not find it out until the furnace was started and the insulation burned off the wires.

The telephone wires should also be kept as far as possible from electric light or other wires in the building, not only for the purpose of avoiding direct contact, but to keep clear of inductive disturbances.

For concealed work the writer prefers to use two separate wires instead of the duplex kind so frequently employed for this kind of work. With two wires the chances are that the insulation of the circuit will be better and for the short distances used in house connections the inductive effects of separate wires are not noticeable as they might be on a longer line. In damp places a rubber-covered and braided wire is always to be preferred, while in very dry places or in very dry climates, as in some of the Rocky Mountain states, weather-proof or even common annunciator wire may better be used, as rubber decays rapidly in dry air. By weather-proof wire is meant a double or triple-braided covering, soaked in some asphaltum compound.

Annunciator wire should not be used

on the outside of buildings for more than a foot or two, and even then never stapled to the woodwork outside. Many wiremen are fond of taking a large number of turns of wire just above the telephone (commonly called "pig-tailing"). When concealed wiring, such as has just been described, is used this is unnecessary, as it is just as easy to cut off an extra foot or two of the wire and shove the surplus back into the wall again, which makes a neater piece of work and at the same time leaves enough end for future changes or possible breaking of wires at the binding-post.

BRICK BUILDINGS.

So far our description of house wiring has applied only to frame houses. With brick buildings the case is somewhat different, and it is generally desirable to place the telephone as near to a window or door as convenient and bring the wires through the framework of the window or door and down the side to the instrument. Sometimes, however, concealed work can be used, as in locations where it is possible to get into a garret and fish a wire down behind the plaster. As most brick walls are separated from the plaster by a furring strip an inch in width, it is possible, by the use of a long No. 12 steel wire, in many cases, to fish down as far as necessary to reach the instrument.

With modern office buildings provisions for all kinds of wires are generally made by the architect when the building is erected, the wires being fished through iron-pipe conduits or mouldings. Where the architect has not foresight enough to plan an installation of this kind, the telephone manager, as well as the managers of all other electrical companies, should use his influence to have it done, in order that telephone, telegraph, district messenger or electric light wires can be placed in every office without extra trouble or expense.

One manager of our acquaintance goes even farther than this, and places telephone wires, or at least a fish wire, in every prominent building in course of erection free of charge, leaving the outside end as near as possible to his pole lines and the inside end where he thinks it will be most accessible to the telephone. This kind of wiring does not cost him much at the time, as he does not fasten it in any way, but leaves it so that it can be pulled out or other wires pulled in whenever desired. Where he goes through joists or floor timbers he bores no holes smaller than a half-inch and slants them so that the wire can be pulled out without difficulty. As tenants of these buildings nearly always want telephones this preliminary work results in a very considerable saving to him in the end, and by allowing district messenger companies to use this same raceway he has no trouble in inducing them to share part of the expense.

It might be remarked here that his object in boring holes so much larger than it seems actually necessary is to avoid cramping the wires in any way, as they then touch the smallest amount of wood, and also to allow the wires to move freely if it ever becomes necessary to pull them out again. Moreover, it allows of other wires being pulled in should it be necessary to install more than one circuit in the building, as a half-inch hole will hold twenty or thirty wires of the kind ordinarily used in such work. If, however, it should be necessary to pull in this number of wires they should then be in twisted pairs instead of the single wires before mentioned, to avoid inductive disturbances. It might also be remarked that a hole considerably larger than the wire allows a free circulation of air around it and does not retain dampness if moisture should get in.

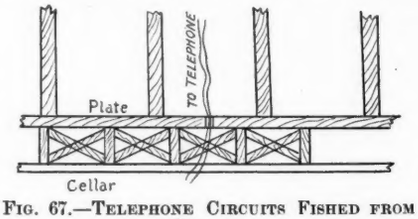


FIG. 67.—TELEPHONE CIRCUITS FISHED FROM CELLAR.

UNDERWRITERS' REGULATIONS.

In large cities where all sorts of wires must of necessity be mingled more or less indiscriminately, many protective devices are required by the boards of fire underwriters; such, for example, as a fuse placed outside of the building where the wire enters and possibly another set of heat coils and carbon-block lightning arresters just over the telephone, with perhaps other heat coils and lightning arresters in the cable boxes and still another set in the terminal room.

While much of this is pure nonsense, yet there is a certain amount of reason in it that at least deserves consideration, even in a small town.

In the first place, while fuses, heat coils and carbon arresters tend to protect instruments, switchboards and buildings against dangerous high-tension currents, and in many places are absolutely necessary to secure even a reasonable degree of safety, yet they constitute extra resistances in the circuit, increase the chances of trouble and at best can only be regarded as a necessary evil. They should not be used where, with perfect safety, their use can be dispensed with.

There are installations in which the use of protective devices seems to have become a fad and many a telephone man who will not use iron wire in his lines because it may add from 50 to 100 ohms to their resistance, will often place at least four more heat coils in the circuit than needed, which, in some types, adds about 400 ohms to his line resistance. Consistency is sometimes as uncommon among engineers as among some other people.

There can be a legitimate as well as improper use of fuses. Suppose, for example, we have an alley in which there are a large number of wires but in which there are no electric light or power circuits. Suppose, also, that the cable ends at the entrance to this alley. Under these conditions it requires no great acumen to discover that there is no chance for a high-tension circuit to get on any of these wires, at least so far as that particular street or alley is concerned.

As the terminal posts in the cable head are usually close enough together to act as a very efficient shield against lightning, it is therefore an absurdity to superimpose protective devices anywhere in this branch. So far as placing fuses or cutouts inside of the building is concerned, judgment should again be used and where there is no danger of any possible contact with a high-tension circuit they should not be used. Even in large cities, where there is considerable danger from currents of this kind, a one-ampere fuse in the cable box is generally sufficient to protect both telephone and circuit. If, however, as in some central battery systems, a ground wire is used at the instrument, then a heat coil, or, rather, a pair of heat coils, should be placed just above the instrument, as the best of condensers are liable to be punctured and maintain an arc under these circumstances. But this does not change the force of the remarks already made, that these accessories should not be used unless the surroundings demand it. Use judgment in all cases.

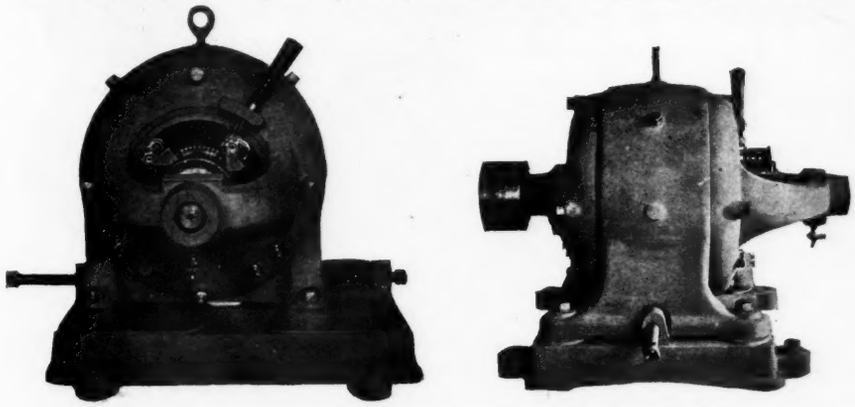
Exposition of American Manufactures Closed.

United States Consul-General Goodnow has sent notice from Shanghai, China, of the discontinuance of the exposition of American manufactures, maintained by the National Association of Manufacturers and known as "The American Warehouse in Shanghai."

Some New Types of Direct-Current Motors and Generators.

Notwithstanding the very general standardization of direct-current electrical apparatus, new designs are constantly appearing which possess points of superior excellence and merit as well as novelty of design. In the accompanying illustrations are shown a type of motor or dynamo recently produced by the Reliance Electric Company, of Milwaukee, Wis., and intended for general power and light uses.

As the illustrations very clearly show, the machine is of the semi-enclosed type, its frame being a solid circular casting of steel, of which the bottom is shaped to form the feet. The four pole-pieces are made of cast steel, of oval section, with pole-shoes cast solidly on the body of the pole-piece. These shoes are so shaped as to hold the field coils firmly in place and at the same time to give the proper magnetic distribution in the air-gap to ensure sparkless commutation. The frame of the machine is bolted down to a cast-iron bedplate by a method better understood from the illustrations than from any description, permitting considerable play sideways to permit tightening the belt and ensuring alignment of a very perfect character. The heads of the machine are made reversible, which is a considerable point of advantage, and carry the gun-metal bearings in which the armature shaft runs. Ring oilers are used, ensuring a generous distribution of oil.



End and Side Views of Semi-Enclosed Direct-Current Motor.

The shaft is made of homogeneous steel, of large diameter, and is ground and polished to highly accurate gauge in the bearing surfaces. The armature discs are stamped out of one piece each, and are assembled upon a cast-iron spider forming a series of air ducts and ensuring ample ventilation. At intervals the assembled discs are separated by a plate forming a series of radial ducts out to the ends of the teeth, through which air is forced by the revolution of the machine.

The armature winding is of the form-wound variety, ensuring very perfect mechanical balance of the running armature, and the coils, after insulation, are subjected to a breakdown test of 2,000 volts, alternating. The field coils are also form wound and are interchangeable, as are the armature coils. The commutators are built up of heavy copper bars, insulated with mica and held in place by steel rings and nuts threaded to the shell. The brush-holder is of the form shown in the illustration and carries carbon brushes of ample size. The four brush-holders are mounted on a ring instead of the usual rocker-arm, and, while their adjustment is entirely simple, the mechanical strength of the arrangement is greatly improved by this construction. The machines represent excellent design and careful attention to all of the details of the mechanical construction.

The Reliance company's factory is very completely equipped for the manufacture of dynamos and motors of from 3 to 250 kilowatts capacity, the company making a number of special machines, such as crane motors and motors adapted to direct-coupling.

At the meeting of the committee of the Liverpool Tramways some very interesting particulars of the working of the electric tramways were given by the chairman. Altogether the tramway system in Liverpool now comprises 100 miles of track, which operates 350 cars and carries over 1,000,000 passengers per week, an average distance of two and one-quarter miles for one penny. The number of passengers carried in the first nine months of the present year amounted to 75,000,000, against 29,000,000 for the corresponding period of 1897. The traffic returns amounted to about $1,750,000, against about $1,095,000. For the present year, to September 30, the gross profits amounted to about $575,000, which, after providing about $375,000 for interest and sinking fund and fully maintaining the whole of the system, left a net profit of about $200,000 for the nine months.

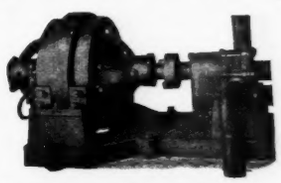
A New Strain Insulator.

A very interesting and novel type of insulator is shown in the illustrations designated Figs. 1 and 2. In this insulator, as is well shown by Fig. 2, all the stresses are of compression instead of tension, which should make it very durable. For the insulation of all parts under stress sheet mica is employed. In the other parts and the exterior moulded mica is used for the insulation. It is said that this insulator has an average breaking strain of 8,000 pounds. The insulator is manufactured by the H. W. Johns Manufacturing Company, of New York.

Figs. 1 and 2.—A New Strain Insulator.

A Motor-Connected Rotary Pump.

A very neat and convenient type of rotary pump connected with an electric motor is shown in the illustration. This style of pump is said to give good results. It is simple, durable and efficient. There is no packing used about the impellers, which are made of a good quality of metal machined by a special device to ensure accuracy. The impellers do not touch each other or the casing of the pump, the fluid forming a packing between the impellers and the casing, as well as between the two impellers. This pump, when connected to an electric motor, makes an excellent arrangement for a house pump, or a pump for large buildings. The pump with its motor is mounted upon a bed-plate and automatically controlled with a motor-starting device, the latter being governed by the level of the water in the tank located some distance from the supply. This pump is built in iron and bronze, and also acid-proof alloys for mining purposes. This pump is manufactured by the Lake Street Manufacturing Company, Chicago, Ill.



A Motor-Connected Rotary Pump.

It is announced that the Cape-to-Cairo line of the African Transcontinental Telegraph Company has been constructed as far as Bismarckburg, Togoland. It is the ultimate intention to connect with it the German East African line, at Ujiji, Central Africa.

A New Ironclad Motor.

A very interesting type of ironclad motor is shown in the illustrations. It possesses many new features and is applicable to a large number of sewing machines which require a small amount of intermittent power to run them.

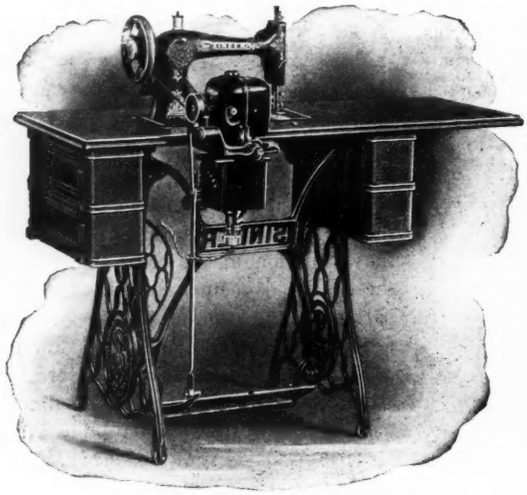


FIG. 1.—SEWING MACHINE MOTOR.

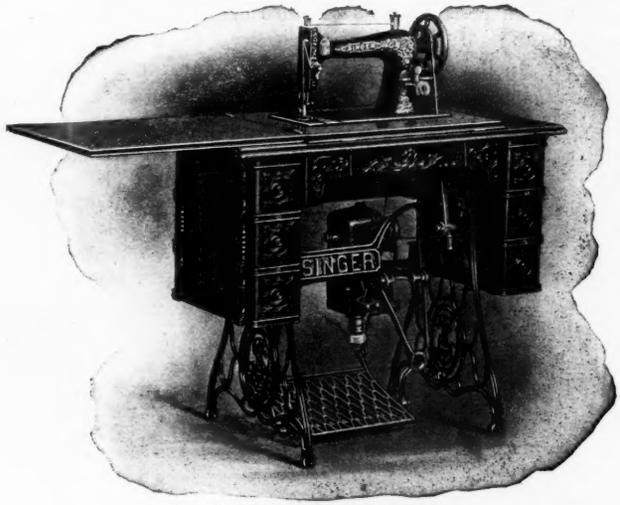


FIG. 2.—SEWING MACHINE MOTOR.

Silk-insulated wire is employed in the armature. It has hard drawn copper commutator bars and self-oiling bronze bearings.

In Fig. 1 a motor, with a brake attachment and speed regulator supported by an iron bracket, is shown. By pressing the treadle downward different speeds are obtained. The current is automatically cut off and the machine stopped instantly by removing the pressure from the treadle.

FIG. 2.—BOX WITH NOZZLE REMOVED AND FLUSH PLUG IN PLACE.

An ingenious arrangement by which the motor, with brake attachment and speed regulator, can be applied to a drop-head machine without making any changes on the machine except to remove the band wheel from the stand is depicted in Fig. 2. An idler, with gravity catch and belt tightener, is included in this outfit. The idler guides the belt through the holes in the lifting plate, and the gravity catch releases the belt when the machine head is lowered into the cabinet.

This motor is manufactured by the Diehl Manufacturing Company, Elizabethport, N. J. Different styles of brackets are furnished for use with any machine.

A Water-Tight Floor Outlet Box.

A very durable and neat type of floor outlet box is depicted in Fig. 1. This box is especially adapted in construction work to bring wires to floor outlets in making connections for electric lines, fans, push-buttons, etc.

Floor outlet boxes are exposed to water and dirt when floors are scrubbed and swept, and from the nature of their location subjected to hard usage. This box has been designed to meet such conditions. It is constructed of heavy cast iron, the floor-plate being of brass or iron three-sixteenths inch in thickness. It will not sink in the floor when subjected to heavy weight. It is said to be thoroughly water and dustproof, being provided with gaskets at the joints and leaded where screw-thread connections are made. The level of the box with respect to the floor can be regulated by simply turning the top.

FIG. 1.—FLOOR OUTLET BOX COMPLETE, WITH SINGLE OUTLET NOZZLE AND CORD.

FIG. 3.—FLUSH PLUG.

In Fig. 1 the box is shown complete, with the single outlet nozzle and cord. In Fig. 2 the box with the nozzle removed and with the flush plug, depicted in Fig. 3, in place, is given. It thus makes a flush floor-plate without the cost of an entirely new lid. This outlet box is manufactured by the General Incandescent Arc Light Company, of New York.

Spiral Filament Incandescent Lamps.

In the accompanying diagrams are shown some results presented by Mr. Francis W. Willcox before the last annual meeting of the National Electric Light Association. Mr. Willcox, in studying the effective distribution of light from incandescent lamps, brought out very clearly the large influence which is exerted by the shape of the filament. In Fig. 1 herewith is shown the horizontal and vertical distribution from a double-loop or twin-filament lamp, and in Figs. 2, 3 and 4 are shown, respectively, the distribution from oval anchored filament, double-coil filament and spiral-filament lamps. It will be noted that in the latter case the distribution is shown as uniform in all directions.

A lamp of this type has lately been manufactured and put on the market by the Sterling Electrical Manufacturing Company, of Warren, Ohio. The lamps are made in the usual voltages and candle-powers and with the usual standard bases to fit the various types of sockets.

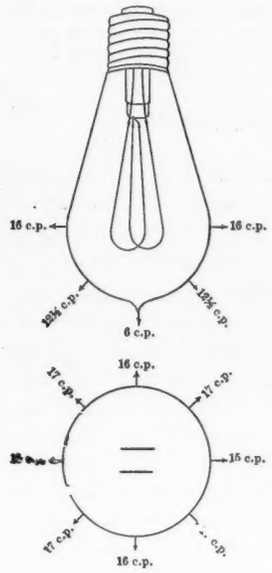


FIG. 1.—DOUBLE FILAMENT LAMP LIGHT DISTRIBUTION.

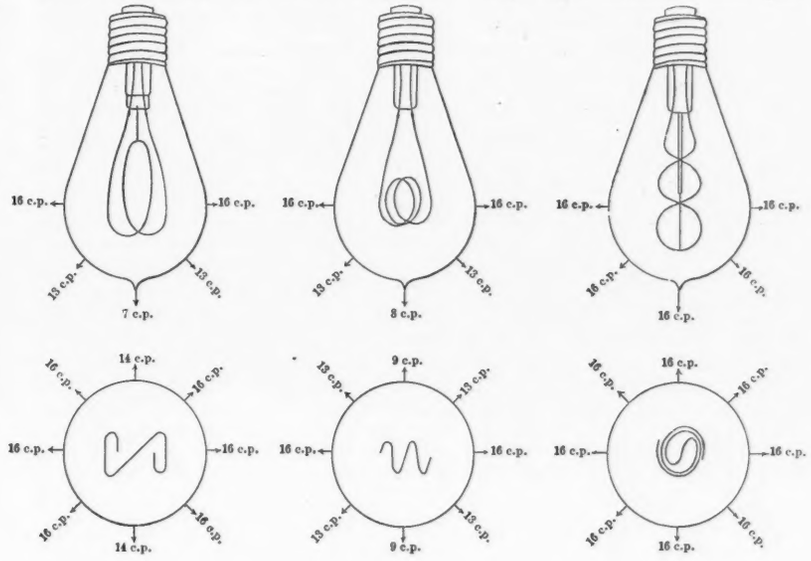


FIG. 2.—DISTRIBUTION OF LIGHT FROM VARIOUS TYPES OF LAMP FILAMENTS.

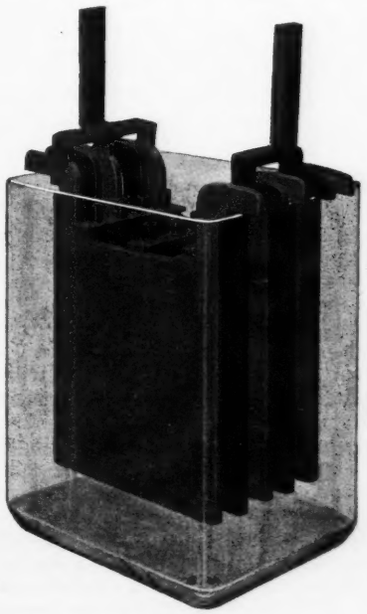
Peat Used for Fuel.

The following news has been sent by United States Consul Bergh, from Gothenberg, Sweden: The Vislanda-Bolmen Railroad has made an experiment with pressed and dried peat as fuel with an extra train, consisting of locomotive, fifteen loaded freight cars and one passenger car. The distance was about twenty-two miles, and the time-table was set for lower speed than the ordinary, but this extra train arrived in due time at the respective stations, and at the final station fifteen minutes ahead of time. Considering the fact that the locomotive in use was built for using coal only, the result of the trial is regarded as very satisfactory.

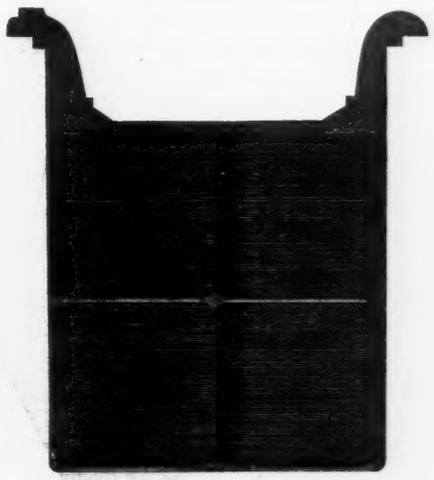
A Modern Type of Formed Storage Battery.

Since the fundamental inventions of Planté and Faure gave to the world, respectively, the types of formed and pasted-plate storage batteries, there has been great activity in the development of the two types, the one being improved along the line of increased service and enlarged contact area between the electrolyte and the plate, while the other has gone through an immense number of changes both as regards the mechanical structure of the plates and the nature of the elements employed.

In the accompanying illustration is shown an element of the formed variety in which the expansion of the surface of the lead has been carried to a very high point, producing a plate having a remarkably high discharge rate per unit of weight. These batteries are manufactured by the Gould Storage Battery Company, which has its factories at Depew, N. Y., and Anderson, Ind. At these works no less than 1,200 men are employed. A large number of the cells are used both for electric lighting and power purposes in automobiles and elsewhere. As many as 4,000 elements are used in the car lighting system controlled by a company of close affiliation to the Gould Storage Battery Company.



STORAGE CELL COMPLETE.



FORMED STORAGE BATTERY PLATE.

The first electric motor was the pendulum of the electric chimes, made by Otto von Guericke in 1632.

News from Great Britain.

(By Our Special Correspondent.)

AS HAS been foreshadowed in these notes for some time now, the dispute as to the electrification of the underground steam railway in London was not amicably settled between the two companies concerned and the course laid down by Parliament to be followed, should such a state of things occur, *viz.*, an arbitration under the ægis of the Board of Trade, was resorted to. To those who keenly follow the question of foreign competition in England it may be pointed out that the arbitration which was carried out under an English Parliament and in the English law courts was to decide which of two foreign systems should be applied to an English railway, for it is an apparently open secret that should Mr. Yerkes and his party gain the day the orders for the equipment will go to America. The Hon. Alfred Lyttelton, M. P., K. C., assisted by Mr. Thomas Parker (Metropolitan company) and Mr. H. F. Parshall (District company), sat for eleven days hearing evidence pro and con, and this tribunal will now report to the Board of Trade, from which, in due course, a final decision will be received. The counsel for Mr. Yerkes fought his case on the argument that the proposed Ganz system was "untried," a doctrine which was counteracted to some extent by the appeal of the opposition that this was disloyalty to science and progress. The principal witnesses for the Metropolitan company were the engineers to Messrs. Ganz, *viz.*, Herren Blathy and Kando, to whose testimony was added that of such men as Professors Thomson and Ewing and Major Cardew, late electrical inspector to the Board of Trade. Against this we had the evidence of Mr. Chapman and Mr. P. Dawson, both American, and Mr. James Swinburne, the redoubtable English professional expert witness, as he has been called. Of course, the enquiry elicited a superabundance of valuable technical details, principally, however, as to the polyphase system, and an impartial observer could not refrain from admiring the amount of igenuity and skill displayed by Herr Blathy in his attempt to foil all his adversaries possible criticisms. In fact, Professor Ewing himself was so carried away that in giving his evidence he commenced to interpolate such a most flattering eulogy of Herr Blathy that the president was forced to remind witness that he was not in a court of mutual admiration.

Whatever the result of this arbitration, one must not lose sight of the fact that Mr. Yerkes has, through his recently promoted Metropolitan District Electric Traction Company, entered in a compact with the District Railway Company to equip all the latter company's lines outside the notorious Circle on the direct-current system. This at once frustrates the efforts to make the selected system on the Inner Circle the future standard when converting the main lines of the country. But, perhaps, at present this may be treated as a detail, although its importance will grow with time. The Austrian engineers have estimated their saving in capital expenditure, chiefly by reason of the absence of costly substations and the necessary attendance, at £140,000, which the continuous-current advocates denied, but took no steps to prove. Space here is far too short to give anything like a complete account of the arbitration proceedings, but my general summing up, as one who attended the function throughout, is that Messrs. Ganz sprang a mild surprise upon their opponents in more than one way and that the American financiers and their English backers were not in such buoyant spirits on the eleventh as on the first day. It is quite evident that Messrs. Ganz have equalized matters in a manner unsuspected by many who knew nothing of their system, and a significant question put by the president to Major Cardew as to the length of time it would take to make trials upon the polyphase system such as would satisfy the Board of Trade as to its general applicability may or may not portend anything. The answer was "a fortnight." The result is hardly likely to be known before the end of the year.

It may not be out of place here to mention, as giving some idea of the extent of Mr. Yerkes's operations on this side of the domain of electrical engineering, the promotion and registration of a company with the modest patronymic of the Union Construction Company, Limited. The subscribers include Mr. Yerkes and Mr. J. R. Chapman, mentioned above, and with a capital of £200,000, its objects are, besides the application of electricity to any tramways or railways in the United Kingdom or elsewhere, the manufacture of rolling stock, etc.

The opening of the large Hackney (London) municipal electricity works is another link in the still incomplete chain of public electric supply stations throughout London and greater London. Hackney is one of the largest of the metropolitan boroughs and this now leaves but two such boroughs without an electrical supply in any shape or form, a state of things which will be remedied ere long, as one of these delinquents is busily putting up a station and the other is applying for powers to do likewise. The feature of the Hackney works is a new type of continuous-current switchboard, built by Messrs. Ferranti, and which they have made their standard pattern. This is a combined lighting and traction switchboard, and is designed for 460 volts lighting and 500 volts traction, and the main advantage claimed by the makers is the absence of the well-known entanglement of cable connections at the back, all connections being in sight in front of the board.

A. W.

London, November 23.

Electric Trains on the Manhattan Elevated Railway.

It is stated by officials of the Manhattan Railway Company, of New York, that two of the large generators in the power-house at the foot of Seventy-fourth street will be started about the middle of this month. These generators are each of 5,000 kilowatts maximum output and are each direct-coupled to an Allis quadruple-cylinder engine of 8,500 horse-power. Two of the units are now fully installed and six more are rapidly being set up. These dynamos are the largest that have been constructed, each of them weighing 185 tons and having a frame forty-two feet in diameter. The rotating fields are thirty-two feet in diameter, and have a peripheral speed of 7,540 feet a minute. The machines generate 11,000-volt, three-phase current directly, this being reduced and converted to direct current in substations. It is stated that the Second avenue line will begin the operation of electric trains, interspersed between the steam-operated trains, about December 15, more electric trains being put on as the men are instructed in their operation and as the equipment of the power-house progresses. All of the stations will be lighted electrically at the same time.

New York Electrical Society.

The two hundred and eighteenth meeting of the society was held Tuesday evening, November 26, and the paper of the evening was presented by Mr. Robert Lozier, and entitled "The Electrical Operation of Modern Tools and Machinery." The paper was very profusely illustrated with lantern slides, showing the extent to which electric motors have been directly applied to driving of varieties of power-using machinery, and a large number of interesting data were made public concerning the methods used, especially the multiple voltage method and speed control by means of double-current generating dynamos. Mr. Lozier also described control methods and showed the varieties of typical designs that had been produced to meet the exigencies of various kinds of machine operation.

The discussion was participated in by Mr. Gano S. Dunn, Mr. H. B. Coho, Mr. Campbell Scott, Mr. F. V. Henshaw, Mr. Arthur Williams, Mr. T. C. Martin, Mr. August Munning and others.

CURRENT ELECTRICAL NEWS

COMMERCIAL NEWS

DOMESTIC AND EXPORT

CUBAN ELECTRIC CONTRACT—News comes that Mr. Hugh J. Reilly, of New York, has received the contract for supplying water and electric light to the municipality of Guines, which is forty-five miles southwest of Havana.

MONTREAL RAILWAY INCREASES POWER EQUIPMENT—The Montreal Street Railway has applied for a permit to erect an addition to its present power-house. The addition is for the purpose of installing machinery in connection with the Chambly electric power plant.

CALIFORNIA POWER PLANT—Mr. Charles D. Lane is said to be interested in a large electric power company which has been organized in Stockton, Cal., for the purpose of supplying San Francisco and other cities with light and power from the Stanislaus River.

TRAINING SCHOOL FOR MOTORMEN—The Manhattan Elevated Railway Company, of New York, has filed plans with the Building Department for a new one-story building which is to be used for instructing the motormen of the third-rail electric system which is now being installed.

LONDON TRACTION NEWS—Mr. Charles T. Yerkes and those associated with him are said to have organized the Union Traction Company under the British Liability Acts for the purpose of undertaking and putting into effect the application of electrical equipment and traction to railways or tramways in the United Kingdom or elsewhere. The capital of this company is given as £200,000.

WASHINGTON TRACTION COMPANY SOLD—The Washington Traction and Electric Company, controlling the street railways of Washington, has been sold to Mr. Brainard Toles for $5,000,000. Mr. Richard B. Tunstall, special master commissioner, made the sale under a decree of the United States Court of the Eastern District of Virginia, in the case where the United States Mortgage and Trust Company was the complainant.

LONG-DISTANCE TRANSMISSION IN CALIFORNIA—The Standard Electric Company of California expects to complete its high-tension line into the Eighth street substation in San Francisco shortly. When this is completed there will be ready for disposal in San Francisco electrical energy developed on the Yuba River and conveyed via the lines of the two great transmission companies, the Bay Counties Power Company and the Standard Electric Company, a distance of 222 miles.

RECENT CABLE WORK—Fortifications have been erected upon three islands; namely, Plum, Gardiner and Gull, which are situated at the eastern entrance to Long Island Sound. These islands are now to be connected with the mainland by cable. General A. W. Greeley and Colonel H. C. Dunwoody, of the United States Signal Corps, are there supervising the preliminary work. Colonel Dunwoody will have the work under his personal supervision after it has been once started.

IMPORTANT CONTRACTS AWARDED—The Boston & Worcester Street Railway Company has elected officers and awarded contracts aggregating $1,500,000 for the construction of a new street railway line from Boston to Worcester. Mr. William Butler was elected president of the company. The contracts were awarded to J. F. Shaw & Company for the immediate construction of the line. The work of building a power-house from which the line will be operated has been begun at Framingham.

MASSACHUSETTS STREET RAILWAYS TO UNITE—Mr. William M. Olin has presented a petition to the Secretary of State desiring legislation to permit the Grafton & Upton Railroad Company, the Upton Street Railway Company, the Milford & Uxbridge Street Railway Company, and the Milford, Hollister & Framingham Street Railway, to contract these railways into one system. The authority for these corporations to lease or sell their franchises and property to any one of them is also sought.

LARGE ADDITIONS TO PLANT—It is said that the General Electric Company will shortly erect three new buildings at its plant in Schenectady, N. Y. These buildings include a three-story brick building 310 feet by 66 feet, to be used for the manufacture of smaller pieces of electrical apparatus, an addition to the iron foundry 20 feet by 100 feet, and a third story to be added to the pattern storage building, making practically a new building of it. Contracts for other new buildings have been let recently by this company.

COMMERCIAL PACIFIC CABLE COMPANY—Mr. John W. Mackay, who is the president of the Commercial Cable Company, which was organized a short time ago, is said to have stated that San Francisco would be the terminus for the cable in the United States, the company considering that the saving in distance if the terminus were in southern California would be more than counterbalanced by the tolls overland to San Francisco; also that the work of laying the section of the cable from California to Honolulu would be started as soon as the cable could be made ready.

TELEPHONE EXTENSION IN THE MIDDLE WEST—The first meeting of the directors of the Interstate Independent Telephone and Telegraph Company, which was recently organized in New Jersey, has been held in Joliet, Ill. This company is capitalized at $3,000,000. It has decided to purchase a number of independent telephone systems besides those which it already owns in Illinois and Iowa. The following officers of the company were elected: Senator Henry H. Evans, Aurora, Ill., president; Frank Tracey, Springfield, Ohio, vice-president; Edward R. Conklin, Joliet, Ill., general manager, and A. B. Conklin, Aurora, Ill., treasurer.

NEW CHINESE ELECTRICAL BOOK—What is said to be the first book on electricity in the Chinese language is being translated in St. Paul, Minn., by Mr. Gong Hee, who is in St. Paul with Mr. Long Ka Tien, the American head of the Chinese Empire Reform Association. Mr. Gong Hee is a graduate of the electrical department of a Portland technical school, and is a practical electrician. His book is to be a complete treatise in simple electricity and electrical application. It is a translation of parts of a number of American text-books, with a large amount of explanatory matter made necessary by the difficulty in translating electrical terms into a language which knows nothing of them.

ELECTRIC TRACTION AT THE GRAND CENTRAL STATION, NEW YORK—It has been announced that the managements of the railways terminating at the Grand Central Station, New York city, are making preparations for the installation of an electric traction system in the terminal section, including the yards and tunnels under Fourth avenue. Mr. Bion J. Arnold, formerly of Chicago, an engineer of great ability, has been appointed electrical engineer for the New York Central Railroad, and under his supervision a series of tests has been carried on lately at Schenectady to secure data of acceleration, draw-bar pull, etc., with electric and steam locomotives for use as bases of calculation and design. No full details of the proposed installation have yet been made public.

ELECTRIC RAILWAYS

BRISTOL, TENN.—The construction of an electric railway between Bristol and Rogersville is being agitated.

HORNELLSVILLE, N. Y.—The building of an electric railroad from Hornellsville to Hammondsport is being discussed.

JACKSON, MICH.—The Main street line of the Jackson & Suburban Traction Company is being relaid with heavier rails.

BELTON, TEX.—Mr. H. M. Carter, of Dallas, Tex., has been granted a franchise for an electric railway from Belton to Temple.

FORT WORTH, TEX.—Mr. George West has been appointed receiver of the Glenwood & Polytechnic Street Railway Line by District Judge Smith.

CULPEPER, VA.—It is said that an electric railway will soon be built to connect Culpeper with Fredericksburg. The survey has already been completed.

MILLBURY, MASS.—A new power station at an expense of about $100,000 has been completed by the Worcester & Blackstone Valley Street Railway Company.

LIMA, OHIO—The capital stock of the Western Ohio Railway Company has been increased from $1,000,000 to $3,000,000, in order to build several new lines.

AVOCA, N. Y.—Those interested in the electric railroad to be built between Elmira and Rochester have been laying out the line and securing the right of way.

UTICA, N. Y.—Ground has been broken by the Utica & Mohawk Valley Railroad Company between Stanwix and Oriskany, for the purpose of erecting a power-house.

MUNCIE, IND.—Mr. Hendrick Leach, who represents the Chase Construction Company, of Detroit, has begun the work of building the Muncie, Hartford City & Fort Wayne Electric Railway.

MARTINSVILLE, IND.—The city council has passed an ordinance granting a franchise to the Indianapolis & Martinsville Rapid Transit Company, which gives the company permission to enter the city.

KITTANNING, PA.—Mr. H. B. Schall is securing the right of way for a trolley line from Kittanning to Rural Valley. Mr. Schall is said to be acting under the direction of Pittsburgh capitalists.

DES MOINES, IOWA—Extensive improvements have been made recently by the Des Moines City Railway Company. Its electrical power equipment has been increased, its lines extended and a new construction and repair shop has just been completed.

HOUSTON, TEX.—Mr. Owen D. Young, of Boston, who purchased the street railway in Houston a short time ago, has conveyed it to the Houston Electric Company, a corporation which was recently organized for the purpose of acquiring and operating the property.

TRENTON, N. J.—Articles of incorporation have been filed with the Secretary of State by the New Jersey & Pennsylvania Traction Company. This company has been organized to construct a street railway in Trenton to carry passengers for a three-cent fare. It is capitalized at $1,000,000.

MT. VERNON, N. Y.—The franchises of the North Mt. Vernon Railway Company have been sold at foreclosure sale, and the Interurban Street Railway Company, of Mt. Vernon, has been incorporated with the Secretary of State as a result of this sale. The capital stock of this company is $500,000.

ELECTRIC LIGHTING

HAMDEN, OHIO—A new electric light plant is to be constructed.

HINCKLEY, ILL.—An electric light plant is being installed in Hinckley.

CASTILE, N. Y.—The Castile Electric Light and Power Company has been incorporated.

GRAND RAPIDS, MICH.—A new electric light plant is being installed by the Grand Rapids Brewing Company.

FRANKFORT, KY.—Mr. C. P. Chenault has purchased an electric light and heating franchise from the city.

CALUMET, MICH.—The construction of a municipal electric lighting plant is being considered by the city council.

LUDINGTON, MICH.—The work of installing a wireless telegraph system between Ludington and Manistee has been begun.

MORRIS RUN, PA.—The work of constructing the new electric light plant is being pushed rapidly by Electrician Goble.

MANCHESTER, N. H.—The water-power plant belonging to Mr. N. G. English has been sold to the Lisbon Light and Power Company.

STOUGHTON, MASS.—The Stoughton Rubber Company will secure power and light from the Stoughton Gas and Electric Company.

PITTSBURGH, PA.—A new electric light plant is being installed at the Ninth street plant of the American Steel and Wire Company.

POTTSVILLE, PA.—The Philadelphia-Reading Coal and Iron Company is constructing a large electric power and light plant at its works.

CASHTON, WIS.—A contract has been made with the Cashton Milling Company to furnish electric light and water power to the municipality.

SUFFIELD, CT.—The Suffield Trolley Company has taken possession of the electric light plant, the purchase of which was made some time ago.

DELRAY, MICH.—An electric light franchise which is wanted by Messrs. Green & Barnes, of the Solway Process Company, is being considered by the Delray council.

FRANKLINVILLE, N. Y.—The Citizens' Electric Light Company has been formed, and arrangements for starting the plant will soon be made by the stockholders.

INDIANAPOLIS, IND.—The Commercial Electric Light and Power Company has applied for a franchise to furnish light and power in the wholesale districts of the city.

TUSCUMBIA, FLA.—A contract has recently been made by the city council with eastern capitalists to build a waterworks system, electric light plant and street railway.

DETROIT, MICH.—The Grand Rapids Light and Power Company has been absorbed by the Edison Electric Light Company, of which State-Treasurer D. McCoy is the president.

LITTLE FALLS, ME.—The streets of Little Falls are being surveyed by the Mallison Falls Electric Power Company for the purpose of installing electric lights and furnishing electric power.

SEATTLE, WASH.—The construction of a city electric lighting plant is being agitated. The plan is to construct a plant on the Cedar River and use the water power for generating electricity.

MOBILE, ALA.—A meeting of the stockholders of the Electric Lighting Company, of Mobile, has been held and the president of the company authorized to increase the capital stock to $300,000.

SAN BERNARDINO, CAL.—The Mentone Power Company has been organized. The company has secured a franchise for erecting the poles and stringing the wires in the roads of San Bernardino County.

COLUMBUS, OHIO—It is said that arrangements are now going on which may lead to the transfer of the majority of the stock of the Columbus Electric Light and Power Company to the Mandlemaun-Pomeroy Syndicate.

OAKLAND, CAL.—The Suburban Electric Light and Power Company has obtained a franchise permitting it to erect and maintain pole lines and supply power and light along the county roads outside the incorporated cities for a period of fifteen years.

NORTH ADAMS, MASS.—The contract for an electric power and lighting plant for the city of North Adams has been awarded to Mr. E. I. Van Doren, of the E. G. Bernard Company, by the North Adams Gas Company.

ONEIDA, N. Y.—The electric light plant of the Oneida Light and Power Company has been sold to the Madison County Gas and Electric Company. The new company by the terms of the contract held by the Oneida Light and Power Company will now light the streets.

NEW HAVEN, CT.—The United Illuminating Company, which controls the New Haven electric light plant, has purchased additional land in the rear of its plant. It is said that the plant will be enlarged and extended to furnish additional facilities for supplying light and power.

TAUNTON, MASS.—Manager Coleman received orders from the city council a short time ago to make a report on the needs of the municipal electric lighting plant. This report has been almost completed. He has laid out plans for a new building together with the machinery necessary for a well equipped economical plant sufficient to supply the demands made upon it.

TELEPHONE AND TELEGRAPH

LINCOLN, NEB.—A telephone line to extend from Lincoln to Garfield is being built.

JANESVILLE, WIS.—The local telephone company has decided to extend its lines into the country.

BANGOR, ME.—The lines of the Union Telephone Company are being extended to South Hope and East Union.

GOWANDA, N. Y.—A new telephone line to connect Silver Creek and Springville is being laid out by surveyors.

PEORIA, ILL.—An independent telephone system is being constructed by the Celestial Mutual Telephone Company.

SHARON, N. Y.—The lines of the Sharon Telephone Company are to be extended to Sharon Mountain and Ellsworth.

HELENA, MONT.—The telephone line between Helena and Billings has been completed and active service begun.

NEWCASTLE, IND.—The trunk line of the Central Union Telephone Company to Louisville has been nearly completed.

DENVER, COL.—The construction and operation of an independent telephone system are being agitated by Mr. William C. Robinson.

TAMPA, FLA.—The work of constructing a long-distance telephone line between Palmetto, Plant City and Tampa is being pushed rapidly.

WASHINGTONVILLE, N. Y.—A telephone line is soon to be built from Washingtonville to Lincolndale by the Highland Telephone Company.

UPPER SANDUSKY, OHIO—A $1,000,000 mortgage has been filed by the United States Telephone Company in favor of the Cleveland Trust Company.

NEWBURGH, IND.—A telephone exchange is now being constructed and will soon be in operation. The system is being built by the Cumberland Telephone Company.

CHAGRIN FALLS, OHIO—The Bell Telephone Company has received the right to use the rear streets and alleys for its telephone lines, or else put them under ground.

NEW ORLEANS, LA.—Mr. L. H. Lancaster, who represents the American Telephone Company, has been looking over the ground preparatory to establishing an exchange.

MIDDLEBURG, FLA.—The construction of a telephone line to connect with the Jacksonville Long-Distance Telephone Company is being agitated by the people of Middleburg.

JOHNSTOWN, PA.—The new building of the Johnstown Telephone Company for its exchange has now been completed. It is a fine structure and contains a modern equipment.

TOPEKA, KAN.—Plans are being made by the Independent Telephone Company to construct a line from Topeka to Meriden. This will open up connections reaching from Atchison to Meriden.

BIRD ISLAND, MINN.—A telephone line from Bird Island to Lake Lillian is being built by the Kandiyohi County Telephone Company, where it will connect with a line to Willmar.

AURORA, ILL.—The headquarters of the Conklin Construction Company, which has received the contract for the work of the Interstate Telephone Company, have been established in Aurora.

NASHVILLE, TENN.—The city council is considering the application for a franchise of the Tennessee Telephone and Telegraph Company. This company proposes to establish and operate a telephone exchange.

JERSEY CITY, N. J.—A force of engineers is making observations for a trunk line for the Interstate Telephone Company between Jersey City and Philadelphia. The purpose of the engineers is to secure a route following the lines of the Pennsylvania Railroad as nearly as possible.

BUTTE, MONT.—A corporation known as the Power Company has been granted a franchise to erect poles and string wires on the public highways of Silver Bow County for the transmission of electric power. It is intended to construct three lines of poles, one for a telephone system and two for power service.

DOVER, DEL.—President Harry Richardson, of the Diamond State Telephone Company, has organized the Maryland & Delaware Telephone Company, to take up and improve the system which was recently purchased from the Salisbury Telephone Company. This company, it is said, will control the Salisbury Telephone Company, the Crisfield Company and the Snow Hill Company.

KANSAS CITY, MO.—The annual meeting of the Missouri & Kansas Telephone Company will be held in Kansas City, Mo., on January 22, 1902, at which time a board of nine directors will be elected and a vote cast upon the proposition to increase the capital stock of the telephone company from $2,500,000 to $5,000,000. The present officers of the company are: John R. Mulvane, president; N. R. Ferguson, secretary and treasurer, and Alonza Burt, general manager. The directors are: J. S. Chick, Alonzo Burt, Frederick P. Fish, N. R. Ferguson, A. G. Fuller, J. R. Mulvane, S. A. Walker, E. Wilder and C. E. Yost. On October 31 of this year the company had 18,500 telephone subscribers, with total stocks and bonds outstanding of $2,838,500.

ELECTRICAL SECURITIES

During the past week the market has remained practically stationary and little has been done. There has been some movements in the securities of the copper industry, but no movement of importance has been chronicled in any other direction of speculative activity. The week was shortened by the Thanksgiving holiday, and many investors have had more reason for genuine thanksgiving this year than they have enjoyed in the recent past.

Securities of the United States Steel Corporation have shown considerable strength, and reports from the various subordinate companies have indicated excellent earnings and a very healthy condition of the market for iron and steel manufactures and wire. The electrical stocks have held their own, as may be seen by the quotations given below. Taken altogether, the week has been one unmarked by any particular movement, and the excellent prices obtained for all stocks and securities are an indication of the good condition in which the country at large finds itself at the beginning of the winter season.

ELECTRICAL SECURITIES FOR WEEK ENDING NOVEMBER 30.

New York:	Closing.
Brooklyn R. T.	64
Con. Gas	219½
Gen. Elec	276½
Man. El	138¾
Met. St. Ry	165⅝
Kings Co. Elec	188
N. Y. & N. J. Tel. Co	166
Telep., Tel. & Cbl. Co	6½

General Electric was very strong. It made a net increase of 14¼ per share, closing the week at 276¼. It reached 281. There is understood to be about an equal division of the directors whether to declare a large stock dividend reimbursing for the scaling down of a few years ago, or to continue to accumulate a surplus.

There was considerable activity on the curb in Consolidated Refrigerating (which includes Axle Car Lighting) and New York Electric Vehicle Transportation. Both stocks scored advances, and further favorable developments are looked for.

Boston, November 30:	Closing.
Am. Telep. & Tel	161
Erie Tel	21½
New Eng. Tel	133
Mass. Elec. pf	94
Westing. Mfg. pf	78½
Edison Elec	240

Directors of the Massachusetts Electric Companies have declared a regular semi-annual dividend of $2, payable January 1, to stockholders of record December 10. The books will not be closed.

Philadelphia, November 30:	Closing.
Elec. Co. of America	6½
Philadelphia Elec	4⅞
Union Traction	32¾
United G. I. Co	117¾
Elec. Stor. Bat. c	64
Elec. Stor. Bat. pf	64

An unofficial estimate of the Electric Company of America net earnings, made in official sources, for the year ending next December 31, 1901, places the amount at $290,000.

Chicago, November 30:	Closing
Central Union Tel	40
Chicago Edison Light	158
Chicago Telep	250
National Carbon	20
National Carbon pf	83
Un. Trac	10¾
Un. Trac. pf	47
Metropolitan El	91

NEW INCORPORATIONS

PARIS, TEX.—Paris Light and Power Company. Increased its capital stock from $60,000 to $120,000.

MONTICELLO, ILL.—Monticello Electric Light Company. Capital stock increased from $10,000 to $20,000.

NEW YORK, N. Y.—Century Light and Power Company. $150,000. Directors: C. B. Hobbs, J. D. Fearhake and others.

YOUNGSTOWN, OHIO—Banner Electric Company of West Virginia. $35,000. Mr. J. E. Lippwitt, of Alexandria, is president.

LA CROSSE, WIS.—La Crosse Gas and Electric Company. $60,000. Incorporators: W. W. Cargill, George MacMillan and others.

PATERSON, N. J.—Paterson & State Line Traction Company. $100,000. Incorporators: Preston Stevenson, Frank Frost and others.

SALISBURY, MD.—The Maryland & Delaware Telegraph and Telephone Company of Wicomico County. $100,000. Directors: John W. Smith, W. B. Miller and others.

TROY, N. Y.—Adirondack Electric Company. $100,000. To furnish light, heat and power for the village of Lake Placid. Directors: A. W. Boynton, H. S. Isham and others.

COLUMBUS, OHIO—The Mt. Vernon, Mt. Gilead & Western Railroad. $10,000. To construct and operate an electric railway. Incorporators: John W. Barry, C. D. Smiley and others.

PONCE, NEB.—Sioux City & Black Hills Telephone Company. $100,000. To build a toll line from Sioux City to the Black Hills, 520 miles. Mr. J. J. Mirathy is president of the company.

MILLINOCKET, ME.—Millinocket Light Company. $20,000. To operate gas and electric plants in the town of Millinocket. Mr. A. Ledyard Smith, of Madison, Me., is president of the company.

FORT SMITH, ARK.—Fort Smith Rapid Transit Company. $2,000,000. To construct and operate an interurban road in Sebastian County. Mr. T. L. Cannon is president of the new company.

MASSENA, N. Y.—Massena & Raymondville Electric Railroad Company. $80,000. To operate an electric road from Massena to Raymondville. Directors: H. H. Warren, W. J. Patch and others.

DENVER, COL.—The Henry Electric Equipment Company. $1,000,000. To manufacture a new machine for lighting and heating railway trains. Incorporators: D. C. Henry, C. T. Elliott and others.

DULUTH, MINN.—Duluth Electric Company. $100,000. To convert water power into heat, light and power, and to carry on all business necessary for its production and distribution. Incorporators: A. W. Hartman, R. B. Knox and others.

ALBANY, N. Y.—Mohawk & Hudson Telegraph Company. $50,000. To operate a telegraph line between Schenectady and Saratoga with branch lines to New York city and throughout the state. Directors: J. H. Stock, William Sells and others.

MADISON, WIS.—Milwaukee Western Consolidated Electric Railway Company. $100,000. To purchase, acquire or build electric railway lines in the state of Wisconsin, and to carry passengers, express, mail and freight. Incorporators: L. G. Brown, H. E. Haskins and others.

PERSONAL MENTION

COLONEL JOHN N. PARTRIDGE, State Superintendent of Public Works, and for many years president of the De Kalb Avenue Street Railway Company, of Brooklyn, N. Y., has accepted the police commissionership of New York city tendered him by Hon. Seth Low, mayor-elect. Colonel Partridge will assume office on January 1, 1902, and will bring to this highly important position experience, ability, discretion and unquestioned integrity.

MR. B. E. FRANKLIN HART, JR., M. E., formerly with the Wheeler Condenser and Engineering Company, has joined forces with Mr. Edwin Burhorn, M. E., lately of the firm of Burhorn & Granger, of New York, and Mr. Barton H. Coffey, M. E., formerly with the International Contracting Company. The offices of the new firm will be located at 62 Wall street and its operations will be in the engineering and contracting line.

MR. MORRIS W. MEAD has been reappointed as chief of the electrical bureau of Pittsburgh, Pa. Mr. Mead held this office for many years until quite recently when a revolutionary movement in municipal politics overthrew the city administration and removed him from his incumbency. For some weeks there has been an interregnum in the bureau, no one competent to take the place having been found. By another turn in the wheel of political affairs, however, Mr. Mead finds himself reinstated. His official record has been marked by a most successful administration of his office and the display of marked ability. His numerous friends will be pleased to learn that his removal was only temporary.

LEGAL NOTES

LIABILITY OF COMPANY SUPPLYING ELECTRICITY—A new question as to the liability of any company supplying electricity to the wires of a street railroad company is decided in Thomas *vs.* Maysville Gas Co. (Ky.) 53 L. R. A. 147, which holds that the company supplying the electricity, as well as the street railway company, is charged with the duty to see that the wires are properly insulated and liable for failure to do so.

INJURIES RECEIVED IN RESISTING EJECTION FROM A STREET CAR—Recovery for injuries received by a passenger in resisting forcible ejection from a street car for refusing to pay fare or leave the car is denied, in Kiley *vs.* Chicago City R. Co. (Ill.) 52 L. R. A. 626, although he tenders a transfer from another line, which should be valid, but is not, because of a mistake of the conductor from whom it was received, where no more force is used than is reasonably necessary to effect the expulsion.

RAILWAY COMPANY CAN NOT CONDEMN LAND OUTSIDE ITS TERRITORY—An attempt by a street railway company to take land for a power-house and coal pockets in a city five miles from its lines, in which it has no authority to run cars, is held, in Re Condemnation of Land By Rhode Island Suburban Railway Company (R. I.) 52 L. R. A. 879, to be for its private benefit, and not for public use, and is therefore not within statutory permission to take, by eminent domain, land necessary for its use.

RIGHTS OF A PASSENGER ON A RUNNING BOARD—The right of a passenger on the running board of a street car to recover for injuries caused by coming in contact with a pillar near the track in attempting to pass around the conductor, who was also on the board, in obedience to the conductor's direction to come forward and get a seat, is denied, in Third Ave. R. Co. *vs.* Barton (C. C. A. 2d C.) 52 L. R. A. 471, unless under all the circumstances he acted as a man of ordinary prudence would have done.

INDUSTRIAL ITEMS

THE CENTRAL ELECTRIC COMPANY, of Chicago, is calling attention to the I. X. L., weather-proof, slow-burning and slow-burning weather-proof wire. This high-grade wire is meeting with a popular reception.

THE GOULD STORAGE BATTERY COMPANY has just opened a branch office in Boston and arrangements are now being made for additional offices in Chicago and St. Louis, where the Gould Coupler Company has offices.

THE NEW YORK & OHIO COMPANY, of Warren, Ohio, is distributing a very neat booklet which sets forth the merits of the Packard lamp and also the Packard transformer. This booklet is entitled "Light Reading," and should be of interest to electrical people.

THE ELECTRIC APPLIANCE COMPANY, Chicago, sales agent for Gutmann wattmeters, manufactured by the Sangamo Electric Company, is jubilant over the fact that although the factory was doubled within the past six months, the orders it is sending in are forcing it again to double its facilities.

THE LEHIGH VALLEY RAILROAD is sending out through its general passenger department an interesting and well-illustrated pamphlet devoted to winter tours. This railroad has recently completed the equipment of its main line between Jersey City and Buffalo with the Hall automatic electric signals.

THE STOW MANUFACTURING COMPANY, of Binghamton, N. Y., has just issued its catalogue No. 9, a very handsome book of seventy-four pages, describing the flexible shafts and multiple-speed electric motors made by the company. The catalogue also describes a number of tools and other auxiliaries made by the Stow company.

THE MORRIS ELECTRIC COMPANY, of New York, has received a contract for the furnishing of general stock supplies for the next six months from the Compania Limitada de Tramvias Electricos de Mexico, of Mexico; and also a contract for general electrical supplies from the Demerara Electric Company, of Georgetown, British Guiana.

MR. BEECHER OGDEN, formerly at the head of the Literary Bureau of the International Correspondence Schools, of Scranton, Pa., has taken charge of similar work for Heinz & Company, the well-known manufacturers, of Pittsburgh. He publishes an interesting monthly entitled "Pickles," which is issued in the interest of the employés and friends of Heinz & Company.

MR. CHARLES E. FARRINGTON, general manager of the Massachusetts Chemical Company, spent several days in New York last week buying machinery for the extension to his company's plant. He states that his company is equipping its factories to manufacture every variety of insulation used by the electrical interests and that in addition to standard work it is manufacturing many specialties to suit the wants of individual manufacturers.

THE WESTERN ELECTRICAL SUPPLY COMPANY, of St. Louis, reports that its demand for line and construction material has been heavier this fall than at any previous time in its business; and states that it is carrying a very large stock of this material, and is prepared to ship promptly any of the many appliances necessary to fix up lines for the heavy winter strain on them. A very complete catalogue covering these supplies is issued by the company.

THE AMERICAN TOLL TELEPHONE COMPANY, 43 to 47 Sheriff street, Cleveland, Ohio, is the manufacturer of high-grade automatic pay stations. This company's machines have met with much success and are sent on thirty days' trial if requested. They are supplied in all sizes and run from single coin to several denominations of our coins. The company also manufactures a call register designed to keep a record of outgoing calls, which can be attached to any telephone.

THE BRISTOL COMPANY, of Waterbury, Ct., has issued circular No. 5, in which its recording pressure and vacuum gauges are described. These gauges give a continuous record day and night of steam, water, gas, oil or air pressure. They are adapted to all ranges of pressure. Users of steam for any purpose should find these instruments of great value as they show at a glance whether the boiler has received the attention upon which depends largely its safety and economy.

THE STANDARD TELEPHONE AND ELECTRIC COMPANY, of Madison, Wis., is now settled in its new factory, entirely rebuilt since the recent fire. In the new buildings, which are of nearly twice the capacity of the former shops, departments have been rearranged in such a way as to enable a volume of business more than double that formerly done to be handled. The company is about to put upon the market multiple and central-energy apparatus and already has advance orders for a number of exchanges.

THE STANLEY ELECTRIC MANUFACTURING COMPANY—The great transmission companies of California utilize almost exclusively S. K. C. apparatus for the production of the tremendous voltages and transmission of enormous power over very great distances. The S. K. C. system is manufactured by the Stanley Electric Manufacturing Company, of Pittsfield, Mass., and received at the Pan-American Exposition the highest possible award, a gold medal, for high-tension alternating-current apparatus.

THE MONTAUK FIRE DETECTING WIRE COMPANY, of which Mr. John D. Gould, 100 Broadway, New York, is president, has received a very flattering notice in the official report of the committee on exhibits of the Pennsylvania State Firemen's Convention, held October 2, 1901. The report concludes: "This exhibit deserves your careful consideration. The wire does not reduce the fire hazard, but it does absolutely give a warning quicker than any other known agency and is a valuable adjunct to protection of life and property. It deserves our hearty endorsement."

THE ELECTRIC STORAGE BATTERY COMPANY, of Philadelphia, has installed 158 batteries of chloride accumulators in street railway service, for the purposes of regulation, carrying the peak during heavy traffic and for use in emergencies. These batteries, representing over 103,000 kilowatt-hours of output, are installed in power-houses, substations and rotary transformer stations, and cover every application of storage batteries to street railway service. Among recent installations are those for the Detroit United Railway, consisting of 250 cells of type 53-G; the Chicago City Railway, 250 cells of 39-G; the Southern Ohio Traction Company, 290 cells of 11-F, and the Fairmount & Clarksburg Railroad, 250 cells of 11-E.

THE BROWN HOISTING MACHINERY COMPANY, Incorporated, of Cleveland, Ohio, has forwarded to the ELECTRICAL REVIEW, through its New York manager, Mr. W. A. Stadelman, a copy of a pamphlet entitled "Brownhoist" Locomotive Coaling Stations. This beautifully gotten-up pamphlet describes new methods of coaling locomotives original with this company and presents illustrations of a plant designed and built by it and now in operation. The economy of operation and compactness of equipment, as well as the distinct novelty of ideas and design embodied in the "Brownhoist" system of coaling locomotives, present many admirable features of marked improvement. The pamphlet should be in the hands of every one interested, and is in itself a very artistic publication.

THE AMERICAN SCHOOL OF CORRESPONDENCE, Boston, Mass., is offering an unusual opportunity to ambitious mechanics who desire to enroll in its correspondence schools to get a handsome and valuable set of books. For the purpose of showing the scope and high standard of the American School of Correspondence, the trustees have voted to apportion a limited number of sets of their special holiday edition of the "Reference Library of Engineering Practice" to be awarded to properly recommended students enrolling for full engineering courses during the month of December. This library consists of the most important instruction papers in its electrical, stationary, locomotive, marine and mechanical engineering courses. It is in five quarto volumes, handsomely bound in half morocco, and contains 2,842 pages, and 1,975 illustrations, consisting of original drawings, sketches, sections, details, etc., illustrating every detail of the subjects treated. It is thoroughly indexed, and is a unique and extremely valuable addition to every progressive man's library. A handsome large handbook, describing methods of instruction and the library in detail, will be sent to any one upon application.

THE CROCKER-WHEELER COMPANY, of Ampere, N. J., is being pushed to its utmost to keep up with the large number of orders it is daily receiving and has on hand. It is constantly adding to the number of factory hands, and has for some months been working a regular night shift. Among the shipments made during the last month are two 520-kilowatt generators for the American Smelting and Refining Company, Perth Amboy, N. J.; three 400-kilowatt generators and one 100-kilowatt generator for the Alsen Cement Plant, West Camp, N. Y.; one 400-kilowatt generator for the Christensen Engineering Company, Milwaukee, Wis.; one 300-kilowatt generator for the Balbach Smelting and Refining Company, Newark N. J.; three 200-kilowatt generators for the Stetson & Company's new power plant, Philadelphia; one 375-kilowatt generator for the Anglo-American Provision Company, Chicago; one 400-kilowatt and one 75-kilowatt generators for the Lake Shore & Michigan Southern Railroad; one 200-kilowatt generator for the Vandergrift Construction Company for railroad work; one 200-kilowatt generator for the Crucible Steel Company, of Blair, Pa.; one 150-kilowatt generator for the Latrobe Steel Company; one 200-kilowatt generator for the Otis Elevator Company and one 100-kilowatt generator for the United States Tube Company. It has also completed the entire shipment of a 45-kilowatt direct-connected generator and fifty or sixty motors for the government printing office in Manila, Philippine Islands. Among the orders recently received are noted the following: two 300-kilowatt generators for the Singer Manufacturing Company, South Bend, Ind.; two 200-kilowatt belted generators for Sayre & Fisher, Sayreville, N. J.; one 60 and one 30-kilowatt generator for the Orange Brewing Company, with various motors ranging from 35 to 2 horse-power in capacity; four 140-kilowatt generators for the Fort Hill Chemical Company, Rumford Falls, Me.; two 75-kilowatt generators for Henry Lang & Company, Newark, N. J.; one 90-kilowatt generator for the United States Electric Lighting Company, Washington, D. C. A shipment of 13 motor-dynamos for the Western Union Company's plant, Milwaukee, and the electrical equipment of the Skinner & Sethman Publishing Company's plant, Denver, Col., consisting of a 40-kilowatt generator and 28 motors, will also be made this month.

List of Electrical Patents Issued Last Week

[Specially reported for this journal by E. S. Duvall, solicitor of patents, Loan and Trust Building, Washington, D. C. Copies of any patent may be secured for 10 cents each.]

ISSUED NOVEMBER 26, 1901.

687,189 System of motor control; W. S. Andrews, Schenectady, N. Y.

687,195 System of train control; E. E. Case, Schenectady, N. Y.

687,222 System of motor control; A. S. Garfield, Paris, France.

687,234 Resophone for telegraph instruments; F. W. Inden, Duluth, Minn.—Comprises the telegraph-sounder, a sound-muffling box enclosing the same, a cover for opening and closing said box, a sounding-trumpet opening through and projecting from said cover, and a pivoted arm on the free end of which said box is pivotally mounted.

687,261 Motor-control system; W. B. Potter, Schenectady, N. Y.—A plurality of series motors connected in parallel, a supply-circuit and means operated by the breaking of the supply-circuit for diverting current from the fields of said motors.

687,292 Power-transmitting device; C. G. Armstrong, Chicago, Ill.—Comprises a rotary driving member, a rotary driven member, both members susceptible of magnetic influences, coils for magnetizing both members and a means for maintaining a higher magnetic strength in a portion of both or either of said members while said portion is within a definite location with reference to the rotary path thereof.

687,297 Electric releasing apparatus for pneumatic-pressure brakes; A. Bruggemann, Breslau, Germany—An air-brake system, comprising the train-pipe, a manometer and an electrically operated outlet-valve connected therewith, and means connected to said manometer to close circuit through said valve to decrease pressure in the train-pipe when said pressure falls below working pressure, thereby operating the brakes.

687,301 Globe or shade for incandescent electric lights; J. C. Fleming Summit, N. J.

687,324 Gun-sighting apparatus; E. W. Lloyd, Newcastle-on-Tyne, England—A target, means for moving the same, a marker, means for connecting the marker to the gun, and an electromagnet operating the marker.

687,344 Refrigerator car; M. E. Schmidt, Princeton, N. J.

687,389 Covering for subterranean cables; O. Wilhelmi, Dusseldorf, Germany.

687,422 Electrical switch; W. C. Calkins, Momence, Ill.—Comprises a number of pairs of pivoted conductors and contact-points, each of U-shape with their open ends facing each other and adapted to receive said conductors, arranged in an electric circuit, and means for conjointly actuating said conductors and engaging them alternately with said contact-points or keepers.

(Continued on page 38.)

ELECTRIC CONDENSERS
WM. MARSHALL, Manufacturer
Standards a Specialty
709 Lexington Ave., New York

$5 VOLT AMMETER FOR STUDENTS' USE.
(Jewell Bearing and Aluminum Case.) Adapted to primary and storage battery work. List of schools using it mailed on application. The method of its use described in a circular just issued.
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PATENTS.
Twenty years' continuous practice with the Western Union Telegraph Company, American Bell Telephone Company, General Electric Company, Electrical Accumulator Company, Postal Telegraph-Cable Company, and other electrical companies.
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: : : CORRESPONDENCE SOLICITED : : :

PATENTS.

(*Continued from page 37.*)

687,428 Magnetic mechanical movement; J. O. Heinze, Jr., Revere, Mass.

687,440 Wireless telegraphy; H. Shoemaker, Philadelphia, Pa.—A receiver for electrical oscillations, comprising an imperfect electrical contact, an insulated ground and air connection, and means consisting of a permanent magnet intermediate of said connections and the contact for giving a greater difference or potential in the contact.

687,455 Static electric generator; L. Frandsen, Sandusky, Ohio.

687,457 Electrode; L. Hargreaves, Farnworth-in-Widnes, England—An electric conductor and detachable anodes, of nipples of conducting material disposed between the conductor and the detachable anodes and bolts for connecting the detachable anodes to the nipples and the nipples to the conductor.

687,473 Electric arc lamp; L. F. Bogia, Jr., Philadelphia, Pa.

687,475 Electric railway switch; W. S. Browne, Brooklyn, N. Y.

687,479 Electric winding clock; W. H. Hall, Chicago, Ill.

687,499 Telephone transmitter; W. W. Dean, Chicago, Ill.

687,505 Electric furnace; M. Ruthenburg, Philadelphia, Pa.—A hopper and a roller constituting the respective terminals of a heating circuit, bearings insulated from said hopper, and arranged to support said roller opposite to the mouth of said hopper and means to rotate said roller.

687,517 Insulating electric conductor and process of making same; W. S. Clark, Schenectady, N. Y.—Consists in coating the same with a thin film of amorphous cellulose compound in a slowly drying solution.

687,518 Apparatus for coating wire or electric conductors; W. S. Clark.

687,522 Electric railway; F. C. Esmond, New York, N. Y.

687,531 Insulating material; C. W. Jefferson, Schenectady, N. Y.

(*Concluded on page 40.*)

WANTED—SEVERAL PERSONS of character and good reputation in each state (one in this county required) to represent and advertise old established wealthy business house of solid financial standing. Salary $18.00 weekly with expenses additional, all payable in cash each Wednesday direct from head offices. Horse and carriage furnished, when necessary. References. Enclose self-addressed stamped envelope. Manager, 316 Caxton Building, Chicago.

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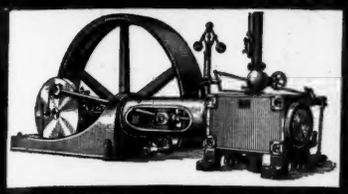

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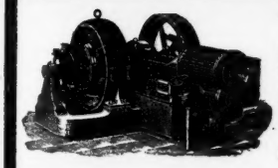

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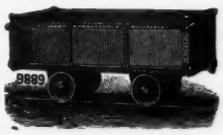

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PATENTS.

(Concluded from page 38.)

687,532 Method of making insulating material; C. W. Jefferson.

687,569 Rheostat; J. Lundie, New York, N. Y.

687,576 Electrical protector; C. A. Rolfe, Chicago, Ill.

687,579 Magnetic separator; F. A. M. Schiechel, Frankfort-on-Main, Germany.

687,612 Process of cementing iron or steel; C. Davis, U. S. Navy.

687,615 Electromagnetic appliance; A. Duppler, Jersey City, N. J.

687,616 Electromagnet and brake-operating connection; A. Duppler.

687,623 Electric transmission of power; J. B. Hall, Chicago, Ill.

687,648 Electric sparking plug; I. C. Orswell, Cambridgeport, Mass.

687,669 Electrical snap-switch; G. B. Thomas, Hartford, Ct.—A commutator-unit for electric switches, contact-rings and insulating layers about them with external clamping-rings and a ferrule flanged over the inner edges of the clamping-rings.

687,681 Electrical apparatus; M. Gally, Brooklyn, N. Y.

687,682 Telephone apparatus; M. Gally, Brooklyn, N. Y.

687,690 Electromechanical actuating device for electric switches, valves, etc.; E. N. Lake, Chicago, Ill.

687,695 Electric lamp; K. Ochs, Berlin, Germany.

REISSUE.

11,952 Wireless telegraphy; H. Shoemaker, Philadelphia, Pa.

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U. S. ENGINEER OFFICE, 735 N. Capitol St., Washington, D. C., November 27, 1901.—Sealed proposals will be received here until noon, December 27, 1901, and then publicly opened, for furnishing Elevator Enclosures, Automatic Elevator Door Openers, and Meaker or Rolling Shutter Doors, for New Building for Government Printing Office. Information furnished on application. JOHN STEPHEN SEWELL, Capt., Engrs.

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At El Paso tourists for California only, who will leave New York February 25, will join the party, and the Mexican tourists who do not care to go to the Pacific Coast will return to New York. The California party will visit Los Angeles and the Southern California coast resorts, San Francisco, and, on the return trip, the Grand Cañon of the Colorado, in Arizona. Tourists will have thirteen days in Mexico and nineteen days on the Pacific Coast, the California tour returning to New York on March 27, the whole tour covering forty-five days. The rate, covering all necessary expenses during the entire trip, will be $575 from points on the Pennsylvania Railroad east of Pittsburg. For Mexico only the rate will be $350, and for California only $375. The party will travel over the entire route in a special train of Pullman drawing-room sleeping cars, compartment, dining, smoking and observation cars. California-only tourists will use special cars to El Paso, and Mexico-only passengers will use special cars returning from El Paso. For detailed itineraries and full information address Geo. W. Boyd, Assistant General Passenger Agent, Philadelphia, Pa.

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